

SATURDAY, APRIL 4, 1925.

CONTENTS.

	PAGE
The Proscription of Darwinism . . . . .	485
Isostasy. By Dr. John W. Evans, F.R.S. . . . .	487
Early Chemistry. By E. J. Holmyard . . . . .	489
On Being Born and Well Born. By F. A. E. C. . . . .	489
Our Bookshelf . . . . .	491
Letters to the Editor :	
Disintegration of Atomic Nuclei.—Sir E. Rutherford, O.M., F.R.S. . . . .	493
The Source of Stellar Energy.—J. H. Jeans, Sec. R.S. . . . .	494
Relation of Light to Bird Migration and Developmental Changes.—William Rowan . . . . .	494
The Mortality of Plaice.—Dr. Geo. P. Bidder . . . . .	495
The Propagation of Radio Waves over the Earth.—T. L. Eckersley . . . . .	496
The Absorption of Cathode Rays in Aluminium.—B. F. J. Schonland . . . . .	497
Absorption of Acids by Purified Silica.—Prof. J. N. Mukherjee . . . . .	497
Method of Measuring Deep Sea Tides.—Prof. R. W. Wood, For. Mem. R.S. . . . .	497
Electricity in Curved Space-time —G. Y. Rainich . . . . .	498
Artificial Incubation. —C. J. P. Cave and T. Vernon Jones . . . . .	498
Solutrean Art.—Miss D. A. E. Garrod . . . . .	498
Mutation. By Prof. R. Ruggles Gates . . . . .	499
The Manufacture of Blue Water Gas. By Dr. A. Parker . . . . .	501
Obituary :—	
Prof. Axel Wirén. By Prof. W. C. McIntosh, F.R.S. . . . .	502
Mr. W. H. Finlay . . . . .	502
Léon Maquerne . . . . .	503
Current Topics and Events . . . . .	504
Our Astronomical Column . . . . .	508
Research Items . . . . .	509
The Molecular Mechanism of Capillary Phenomena. By N. K. Adam . . . . .	512
The Syrian Arc. By Prof. J. W. Gregory, F.R.S. . . . .	514
Permanent Magnets . . . . .	514
University and Educational Intelligence . . . . .	515
Early Science at Oxford . . . . .	516
Societies and Academies . . . . .	517
Official Publications Received . . . . .	520
Diary of Societies . . . . .	520

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The Proscription of Darwinism.

ON March 23 the Governor of Tennessee signed a Bill which enacts that "it shall be unlawful for any teacher in any of the universities, normal schools, and all other public schools of the State which are supported in whole or in part by the school funds of the State to teach any theory that denies the story of the Divine Creation of man as taught in the Bible, and to teach instead that man is descended from a lower order of animals." This Act marks another important advance in the outlawry of Darwinism in American education. Tennessee is one of the most enlightened of the Southern States, but it has followed the example of five others. The last previous action, as stated in Prof. J. W. Gregory's "Menace of Colour," 1925, p. 74, was the unanimous decision last July of the State Education Committee of Georgia to refuse grants to any school or university which teaches the doctrine of evolution. The Legislature of Florida had earlier decreed, also unanimously, that it is "contrary to the public welfare for teachers paid by taxation to teach as a fact any hypothesis that links man in blood relationship with any lower form of life." A Bill with the same purpose was defeated in Kentucky by one vote only. Text-books of biology have been debarred from schools in North Carolina because they asserted a relationship between man and monkeys.

This proscription of Darwinism is the result of two main impulses—one religious, the other racial. The religious impulse is the more publicly expressed, and is doubtless the more influential. The Fundamentalists in the United States are as powerful as the Evangelicals were in England seventy years ago. The conclusions of "The Origin of Species" were denounced by Bishop Samuel Wilberforce to the British Association at Oxford in 1860; and his argument that they are inconsistent with Genesis had to be taken seriously. The support to that position had become negligible in England fifty years ago; but its survival in the United States is shown by the writings of Mr. W. J. Bryan, who has been thrice candidate for the Presidency, and was State Secretary in Wilson's cabinet. His theological books, including his "The Menace of Darwinism, and the Bible and its Enemies" (1921), "In His Image" (1922), and "Shall Christianity remain Christian?" (1924), are written in the frame of mind of Wilberforce; and as the Bishop repudiated an ape as his ancestor, Bryan represents Darwinism as adding insult to injury by insistence that man has descended, not from an American, but

from an African monkey. Bryan regards the Modernists as descending from Christianity to Atheism by successive adoption of seven grievous errors—"The Bible not infallible; Man not made in God's image; no miracles; no Virgin Birth; no Deity; no Atonement; no Resurrection." The multitude of those who make this descent is attributed to Darwinism. "The principal objection to Evolution," says Bryan, "is that it is highly harmful to those who accept it, and attempt to conform their thought to it. Evolution does not ruin all who accept it, neither does smallpox kill all who take it. In fact only five per cent. of those who take smallpox die of it. The spiritual mortality among evolutionists is greater than that." Bryan is probably right in his view that Darwinism has been the most effective factor in undermining belief in the literal inspiration of the Bible. Hence it is charged with being the main cause of the asserted decline in American morals and ethics. "Darwinism," says Bryan, "chills the spiritual nature and quenches the fires of religious enthusiasm." Fairhurst, in his "Atheism in our Universities," complains that their influence is ruinous; he declares that most of the students drink, half of them gamble, and only a tithe of them are interested in religion. A census is claimed to show that eighty-five per cent. of the students enter the Universities as Christians; the number of sceptics is doubled in the first year and trebled by graduation. Some Fundamentalists describe American society as "brought to the verge of ruin by a godless philosophy," which is based on evolution. Hence Bryan declares "Evolution is the Menace of Civilisation. It is the greatest menace to civilisation as well as to religion. Belief in God is the fundamental fact in society; upon it rests all the controlling influences of life. Anything that weakens man's faith in God imperils the future of the race."

Bryan's attempt to refute Darwinism is futile. It is, he says, "not science at all; it is guesses strung together." In support of its unscientific character he quotes "Dr. Etheridge, Fossilologist of the British Museum," and misrepresents modern authorities such as Bateson. The main charge against it is that it is "not only groundless but absurd and harmful to society," as it rests on the brute doctrine of survival of the fittest, which is said to encourage selfishness, to be fatal to the spirit of brotherhood, and to render certain the destruction of modern culture by international and industrial war. Men with such convictions naturally feel bound to prevent national funds being used in the spread of such pernicious doctrine. No teacher in a

public school in the States would be permitted to teach that monarchy is superior to republicanism, and Bryan objects to public funds being used to sap national faith by "teaching daily what cannot be true if the Bible be true." He claims that men of science are a small minority and should not be allowed to use the public schools for the dissemination of their subversive dogmas.

The campaign against Darwinism also gains support from the objection to its evidence of a common ancestor for the Negro and Caucasian. The extent of this impulse is uncertain, but it is significant that the six States which have taken action against evolution are all in the south. On this question the Bible would appear to agree with Darwin; for did not Paul on Mars Hill declare that God "hath made of one blood all nations of men"? Some Americans avoid this difficulty by denying that negroes are descendants of Adam and claim that accordingly they are not men. The negro is a soulless animal at the head of the ape family! Believers in Noah's Deluge may fairly claim that the negro cannot have varied from the white stock as quickly as would be necessary to explain his appearance on earlier Egyptian records. If the negro be not a descendant of Noah, the Bible statements regarding "all men" are held not to apply to him.

The inter-racial difficulties in the southern states have certainly helped the anti-Darwinism agitation indirectly; for their educational backwardness and the poverty of one section of their people is due to the presence of the negro and to cheap negro labour. Recent statistics show that in two counties in North Carolina the white crofters and "renters" have a cash income per person of fourpence and sevenpence per day respectively; the corresponding classes of negroes earn a penny a day more. Families with such income cannot afford education, books, newspapers, doctors, or enjoy a reasonable standard of life. It is not surprising that they retain beliefs which, according to British notions, are decades out of date.

Bryan's eloquence and sincerity have made him perhaps the most powerful recent individual influence in American politics. But he has often failed to persuade his countrymen to adopt his policy. His present appeal for trust in the Rock of Ages rather than in "Ages of Rocks" may carry still further the educational outlawry of Darwinism; but it will probably fail in the end as completely as his famous appeal to the United States to adopt bimetallism "to save a world crucified on a Cross of gold."

### Isostasy.

*Isostasie und Schwermessung. ihre Bedeutung für geologische Vorgänge.* Von Prof. Dr. A. Born. Pp. iii + 160. (Berlin: Julius Springer, 1923.) 2.20 dollars.

THE variation from place to place of the intensity and direction of the force of gravitation is one of the comparatively few phenomena from which we can obtain some knowledge of the nature of the earth's interior. We owe to Pratt and Airy the demonstration in 1855 that, broadly speaking, different regions of the earth's crust balance one another, or, as it is now expressed, are in a state of isostasy; that the weight of mountain masses above the sea-level is compensated by a defect of density below them, and that ocean deeps are underlain by material of high density. But, whereas Pratt believed that the high places of the earth were the result of expansion of the material beneath them, Airy compared a mountain range to a log of wood floating in water, which it displaced and by which it was buoyed up. After nearly seventy years the same difference of opinion as to the real meaning of isostasy continues to persist.

In his treatise on isostasy and gravitation, Prof. Born has furnished us with a comprehensive exposition of the different methods of interpreting the results of gravity determinations and of the evidence that, in conjunction with geological data, they afford of the internal structure of the earth.

The intensity of gravitation at any point is accurately determined by observing the number of swings of a pendulum of known length during a period recorded by a chronometer, checked by astronomical observations or wireless time-signals. At sea other less exact means have hitherto been employed, but Dutch observers have now shown us that pendulum observations can be carried out in a submarine sunk to a sufficient depth to be practically free from wave action.

In the United States, numerous observations have been made by J. F. Hayford and William Bowie, of the U.S. Coast and Geodetic Survey, and the values obtained have been made the basis of calculations to show how far the principle of isostasy corresponds with the facts (U.S.C. and G.S. Special Publications, Nos. 10, 12, 40, 69, and 99).<sup>1</sup> In these the value experimentally determined,  $g$ , is compared with a calculated value,  $\gamma$ , based on the assumed value,  $\gamma_0$ , at sea-level<sup>2</sup> at a point directly below. To obtain  $g$  from  $\gamma_0$  the following corrections are made: (1) for difference of altitude;

(2) for the attraction of the local rocks above sea-level, assumed to have a density of 2.67; (3) for the defect of density below sea-level necessary to compensate for the weight of the rocks above it. The difference  $g - \gamma$  is the isostatic anomaly of Hayford and Bowie. It is quite small, usually less than 0.05 of a dyne, but occasionally approaching a tenth of a dyne.

In calculating the effect of the compensating defect of density, they assumed that it was distributed uniformly below the point of observation from sea-level down to a depth known as the level of compensation, where the density and pressure were supposed to be everywhere uniform. Various depths were taken as the basis of calculation, and that which gave the lowest isostatic anomalies was supposed to be the nearest approximation to the level of compensation. On this basis Bowie obtained for mountainous areas a depth of 95 km. Calculations by Hayford based on deflexions in the direction of gravitation gave a depth of 97 km. Accordingly, Bowie assumed a depth of 96 km. in place of 113.7 km. previously adopted by the Survey. The depth of compensation derived from gravity data at low stations would be indeterminate, but there can, in my opinion, be little doubt that in plains and even plateaux a level of practically uniform density and pressure would be found at a much smaller depth, say 20 or 30 km.

The truth is that the idea of a level of compensation does not correspond to any important reality in Nature. It has no more significance than the level of the base of the largest and deepest of a number of icebergs. It seems obvious to a geologist that the amounts of compensation corresponding to different elevations are not to be represented by columns of equal depth and different densities, but by columns of approximately equal densities but varying depths. In other words, the loftier the mountain range the deeper its foundations extend into the earth. Both mountains and their foundations appear to be mainly composed of similar comparatively light material, the "sial" (sedimentary and acid crystalline rocks), which in general rests upon and in mountain areas displaces more or less the heavier "sima" (basic material) below.

Isostatic anomalies are in some cases to be attributed to the support afforded to local elevations by the intrinsic strength of the earth's crust. This support is, however, given only for a limited time, except by rocks in the closest proximity and at a comparatively low temperature. Isostasy is a condition to which there is a constant approximation but which is never reached; for new developments, such as sedimentation or erosion, the formation or melting of ice-caps, and lateral compression or tension, are continually arising, which tend to destroy it, and then the process of

<sup>1</sup> Reference should also be made to the paper by the author to the Geological Society of America by the president, Oliver W. Smith, "Gravity Observations from the Standpoint of Local Geology" (Bull. Geol. Soc. Am., vol. 35, pp. 207-278, 1924). See, in addition, Andrew C. Lawson, "On the Geological Implications of the Doctrine of Isostasy," Bull. Nat. Res. Council, vol. 5, part 4, pp. 22, 1924.

<sup>2</sup> By sea-level is meant the surface of the rotation ellipsoid adopted in 1912 by the U.S. Survey for the figure of the earth. As a matter of fact the computation is first made on the basis of the Helmert triaxial ellipsoid of 1901, with a subsequent correction (for U.S.A.) to the value of  $g - \gamma$  of -0.008 dyne.

adjustment has to recommence once more. Other anomalies, perhaps the majority, can be best explained by the local occurrence near the surfaces, of rocks or deposits of a density differing in a marked manner from that assumed.

There is another method of reduction of gravity determinations, that of Bouguer, which throws more direct light upon the geological structure of the crust. The observed value,  $g$ , is reduced to what it would be at sea-level<sup>3</sup> if the whole of the rocks above (near enough to exercise any appreciable attraction on the point of observation) were removed. This value is indicated by the symbol  $g''_0$ , and the difference  $g''_0 - \gamma_0$ , where  $\gamma_0$  is the theoretical value at sea-level, affords information of the depth to which the sial extends below it.<sup>4</sup> This is illustrated by an interesting map, by Kossmat and Lissner, of Middle Europe from Denmark to Sicily, showing the relation of  $g''_0 - \gamma_0$  to the great folds of sial, which form both the mountains above and their foundations below.

The whole subject of the relation of isostasy to mountain building, erosion, sedimentation, glaciation, and different types of earth structure is discussed in detail by Prof. Born. He makes the freest use both of the American determinations and of those of the Indian Topographical Survey, which will always remain a monument of the enterprise of Sir Sidney Burrard and his colleagues. Prof. Born gives a detailed account of the work of Hecker and others in marine areas, and of the light thrown by the results obtained by Hecker, Borrás, Kohlschütter, and Krenkel on the nature of the rift valleys of Africa and South-western Asia.

Other subjects dealt with by Prof. Born are pseudo-anisostasy, the apparent departure from isostatic adjustment resulting from the attraction of rocks which do not form part of the column immediately below the point where gravity is determined, so that their weight is not included in that of the column; observations in oceanic volcanic islands—which usually show an excess of gravitational force due to a lag of isostatic adjustment; the relation of earthquakes to the want of isostatic adjustment; and generally the assistance afforded by observations of variations in gravitational force in the interpretation of the meaning of the present configuration of the world, and of the changes which have taken place in its past history.

Prof. Born's work is usefully supplemented by two memoirs from the Finnish Geodetic Insti-

<sup>3</sup> Here it is the surface of the "geoid," the level at which the sea would stand if admitted by canals to a point immediately below the point of observation. It differs but little from the triaxial ellipsoid of Helmert or the rotation ellipsoid of Hayford and Bowie.

<sup>4</sup> It would be better if the expression  $\gamma_0 - g''_0$  could be employed, where  $\gamma_0$  represented what would be the force of gravity at sea-level if the earth's crust below it were composed entirely of sima, for this difference would roughly correspond to the depth of the sial below sea-level.

tute.<sup>5</sup> Dr. Heiskanen has calculated the isostatic anomaly in a number of localities in Europe and the Caucasus. These calculations have been made, first on the same lines as those employed by Hayford and Bowie, and secondly on the Airy hypothesis that it is the *depth* of the lighter material that varies. From the isostatic anomalies obtained in this way it would appear that the latter hypothesis is more in accordance with gravity determinations than the former. This is the case even with the determinations in the United States with which Hayford and Bowie have worked. At the same time, the results obtained indicate that the thickness of the "earth's crust" (presumably that of the sial) below sea-level varies in different localities. Another important conclusion is that the idea that mountain ranges are not compensated separately but only in conjunction with their marginal depressions (Randsenken), and that the former are therefore under-compensated and the latter over-compensated, must now be abandoned. It has been supposed that the Harz and Riesengebirge are uncompensated. Dr. Heiskanen denies that this is the case. The detailed account of the results of the triangulation of South Finland is also of great interest. It contains (*inter alia*) a comparison of the deviations of the direction of gravity actually observed at the triangulation stations with those calculated from the orographical features and the compensation determined by the methods of Hayford and Bowie. The knowledge of the details of the topographical features is, however, at present too imperfect to allow any conclusions to be drawn.

Comparatively few contributions to gravitational data have come in recent years from the British Empire—with the conspicuous exception of India—though so much requires to be done within its limits. It is greatly to be desired that we shall in the future take a due share in this important work.

The recent meeting of the Geodetic Union in Madrid included a section devoted to isostasy. Unfortunately, the German and Austrian men of science, who have done so much to advance knowledge in this direction, were not permitted to attend. Their co-operation would have been all the more valuable because they have worked on lines somewhat different from those pursued in India and the United States. They have taken the fullest advantage of the information afforded by a century of geological research on the structure and past history of the earth's crust. It is absolutely necessary that geodesists and geologists should work in the closest association with one another if trustworthy conclusions are to be reached. JOHN W. EVANS.

<sup>5</sup> "Untersuchungen über Schwerkraft und Isostasie," von W. Heiskanen; "Die Beobachtungsergebnisse der südfinnischen Triangulation in den Jahren 1920-23" (Veröffentlichungen des Finnischen Geodätischen Institutes No. 4 and No. 3). Helsinki, 1925.

### Early Chemistry.

*The Story of Early Chemistry.* By Prof. John Maxson Stillman. Pp. xiii + 566. (New York and London : D. Appleton and Co., 1924.) 18s. net.

THE "noticeable gaps" which so many books are "intended to fill" are often discernible only to the authors. However, the absence of any book in the English language which deals adequately with the early history of chemistry will have been brought home very forcibly to all those whose business or inclination has led them to inquire into the available literature on this subject. It is therefore with genuine pleasure that we welcome the late Prof. Stillman's thoughtful and scholarly treatise—a pleasure that is, alas, tinged with regret at the author's death just before the book was published.

As Prof. Stillman remarks in his preface, modern historians of chemistry have laid the emphasis upon the more recent development, so that it was very desirable to write a history of early chemistry which should incorporate the results of the investigations of Berthelot, Duhem, von Lippmann, Ferguson, Sudhoff, and other scholars. It may be said at once that the author has admirably accomplished the task—no light one—which he set himself. His book is brightly written, well balanced, and extremely accurate both in the main ideas and in the illustrative detail. No scientific library can afford to be without it, and this by reason of its intrinsic merits, quite apart from the fact that it has at present no competitors. A very valuable feature of the book is that, while avoiding a show of erudition, it gives full references to authorities for all important statements, and will thus prove useful to those who are engaged in research upon the history of chemistry.

In a field which extends from the beginnings of civilisation to the Chemical Revolution, no one man can hope to be infallible throughout. Prof. Stillman was especially interested in the fifteenth century, and in his account of this period he is seen at his best. He evidently has here a close acquaintance with the original sources, and his description is penetrating, sympathetic, and sound. For the other periods, he has relied chiefly upon the work of other scholars, but his judgment in the use of authorities is seldom at fault and is generally very shrewd. Particularly good is the first chapter, which deals with the practical chemistry of the ancients. On the question of the origin of chemistry he is not so trustworthy, and seems to be quite unaware of the theory of the growth of civilisation now so warmly advocated by Prof. Elliot Smith and Mr. W. J. Perry—a theory which has a very direct bearing upon the problem of the birth of chemistry.

The theories of the ancients upon matter and its changes (Chapter iii.) are described adequately but by no means comprehensively. Justice is scarcely done to the Greek thinkers, although we are pleased to see the stress which Prof. Stillman lays on the *Timæus*, the influence of which upon medieval chemical thought was very considerable.

That the description of chemistry in Islam is thoroughly unsatisfactory is no reflection upon Prof. Stillman. From the published work on this subject which he had at his disposal, he could not possibly have produced a better account than he has done. He might, however, have got an Orientalist to look through his transcriptions of proper names, and thus have avoided such needless errors as *Moaoma* for *Mu'āwiya*, *Oneeyade* for *Omayyad* (p. 175), and *Eç-Confy* for *Al-Sūfī* (p. 176). These are details which should receive attention in the second edition.

In dealing with the seventeenth century, again, Prof. Stillman has almost entirely neglected the brilliant series of chemists at the Jardin des Plantes—Béguin, Davidson, Glaser, and others—who did much to prepare the way for the great Lemery. Taken as a whole, however, the book is a worthy example of modern American historical scholarship, and may justly claim to rank with Cajori's "History of Physics," Smith's "History of Mathematics," and Lynn Thorndike's "History of Magic and Experimental Science."

E. J. HOLMYARD.

### On Being Born and Well Born.

*Genetics and Eugenics: a Text-Book for Students of Biology and a Reference Book for Animal and Plant Breeders.* By Prof. W. E. Castle. Third edition. Pp. viii + 434 + 60 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1924.) 12s. 6d. net.

THE fact that this third edition is subdivided into forty-two chapters, six of them new, may provide an indication of the variety of the topics which interest the geneticist. In American literature this book, not the least remarkable feature of which is its cheapness, occupies the position which Punnett's "Mendelism" and Thomson's "Heredity" together hold on the eastern side of the Atlantic: it offers to a very wide public an introduction to genetical fact and theory and some notion of the applications of the science in agricultural and sociological endeavour. Associated with this edition there is a laboratory manual which outlines a very useful half-year's elementary experimental course in genetics. Most of the experiments demand the employment of *Drosophila melanogaster*, but this does not make the manual unsuitable, for there is an adequate supply of this

unrivalled experimental material now available in Great Britain as well as in the United States.

The book is not meant to be a text-book for a class in genetics: the intention of its writer is that it should be a text-book for students of biology and a reference book for animal and plant breeders. The characteristic stamp of the personality of the author is too deeply impressed upon its pages, in our opinion, for the book to be the ideal introduction to the subject for the student of general biology, and the value of those chapters which deal with the phenomena of inheritance in the different species, great as it is to-day, must quickly become depreciated in view of the recent appearance of such monographs as are included in "*Bibliographia Genetica*." To the geneticist, however, the book is most attractive, for in no other form could the views of the author, who, both as teacher and as experimenter, has contributed so notably to our knowledge of genetics, be so attractively placed on record.

There is abundant evidence in this book that Prof. Castle knows his rodents: that he knows his fowl as well is not so certain. On p. 77, for example, he submits that "one condition on which the crowing instinct of cocks rests is the production in its body of substances produced by the testis." While it is certainly true that the gonadless fowl does not crow, it is equally true that a cock castrated and with an ovarian implantation will do so, and that a hen, perfectly normal in structure and functioning in every way as a hen, will, in the protracted absence of the male, crow most vigorously, though her voice may not be so full of challenge. On p. 300 it is stated that "fowls of both sexes will develop the same plumage characters, viz. the full plumage of normal males, if no secretions interfere." It is true that the plumage of the capon and the poularde is as that of the normal male in colour and structure, but that of the gonadless bird is far more luxuriant in its growth and far looser in its texture than that of the functional cock. We think also that Prof. Castle accepts with too little reserve the suggestion that the "luteal" cells in the ovary of the hen and in the testes of the henny-feathered cocks are the source of an internal secretion which inhibits cocky-feathering. The weight of modern opinion is quite opposed to this contention.

In discussing the relation of Mendelism to mutation and evolution, the author submits that the Mendelising characters of the domesticated mammals consist very largely of such economically unimportant qualities as coat-colour, hair-length, or hair slope, and that the really valuable characters, such as those of size, proportion, early maturity, milk-yield, butter-fat content, wool, and fecundity, are not typically Mendelian in their inheritance, but are examples of

blending. We were about to debate the question as to what exactly the author regards as typically Mendelian when a few lines further on we found that Prof. Castle acknowledges that very likely the inheritance of these complex characters of economic importance is also Mendelian. He provisionally accepts the conception of multiple factors, but is mistaken in assuming that such a theory demands that there shall be no dominance.

Forty-seven pages are devoted to eugenics. In a book such as this, written for such a public, it is indeed desirable, we think, that an outline of the facts of human inheritance should be included, for the determination of the extent to which mankind is subject to the general principles of genetics is most certainly a biological problem and one that should be brought to the notice of the student of biology. To determine how far these principles are socially controllable, on the other hand, is a problem for the sociologist, and Prof. Castle, a geneticist, makes no serious attempt to deal with it. However, he closes the book with a somewhat pessimistic chapter on "The Possibility and Prospects of breeding a better Human Race," in which he calls largely upon the conclusions of Prof. Cattell, drawn from the latter's study of the families of the one thousand leading men of science of the United States.

We commend this book especially to those who enjoyed and so ceaselessly quote "*Eugenics and other Evils*." They will find therein such conclusions as the following reached by one who is qualified to speak with some authority. The normal unperverted instincts of the average man have a distinctly eugenic trend. Cupid is a safer guide in matrimony than a licensing board. Racial crossing among men, as among domesticated animals, is biologically beneficial within limits. This mixture of elements not too dissimilar, provided the social heritage is not unduly disturbed, is on the whole beneficial. Biologically the human race can be improved only by improvement of the germplasm. If, as seems probable, acquired characters are not to any considerable extent inherited, then environmental agencies affect man chiefly culturally, not biologically. Practically we are limited to such eugenic measures as the individual will voluntarily undertake in the light of present knowledge of heredity. It will do no good, but only harm, to magnify such knowledge unduly, or to conceal its present limitations. We should extend such knowledge as rapidly as possible but not legislate until we are very sure of our ground.

With such conclusions all geneticists will agree. This being so, it is as unjust to blame the geneticist for the mishandling by the lawmaker or enthusiastic sociologist of the facts that he discloses, as to hold the chemist responsible for the adaptation by others of the results of his research to the purposes of war. F. A. E. C.

## Our Bookshelf.

*Meteorological Office: Air Ministry. British Rainfall, 1923. The Sixty-third Annual Volume of the British Rainfall Organisation. Report on the Distribution of Rain in Space and Time over the British Isles during the Year 1923, as recorded by about 5000 Observers in Great Britain and Ireland.* (M.O. 269.) Pp. xxii+256. (London: H.M. Stationery Office, 1924.) 15s. net.

AN analysis of the rainfall for the year is given covering the whole of the British Isles. The year was decidedly wet, being the wettest year since 1916 except in Ireland. The largest excesses occurred in the west. There were more days with rain than in any other year since comparable statistics began in 1903. The average monthly rainfall during the year over the British Isles as a whole varied from 6.5 in. in February to 1.4 in. in June; only two months, March and June, showed considerable deficiencies. February 1923 is said to be probably the wettest February on record. Rainfall maps for the British Isles are given for each month, as well as for the summer and winter seasons and for the year.

Examples of dramatic weather during the year are given, these occasioning floods in different parts during July and November. Serious floods occurred at Carrbridge in Inverness-shire on July 8, and on the night of July 9-10 a memorable thunderstorm was experienced, and about 7000 flashes of lightning occurred during 6 hours in London and the suburbs, while 4.55 in. of rain fell in Sussex.

A special article is given on the fluctuations of annual rainfall; a comparison is made of different groups of 35 years in the period 1868 to 1921, and also with the standard period 1881 to 1915, the 35 years' average in general use in the Meteorological Office. The averages for the different periods of 35 years show a good general agreement. C. H.

*Bearbeitung einheimischer Tiere.* Herausgegeben von Prof. Dr. E. Korschelt. Erste Monographie: Der Gelbrand *Dytiscus marginalis* L. Erster Band. Pp. v+863. Zweiter Band. Pp. vii+964. (Leipzig: Wilhelm Engelmann, 1923-24.) n.p.

THESE two bulky volumes constitute the first of a series of monographs dealing with the fauna of Germany, the subjects selected forming a series of "types" of the animal kingdom for study in the university courses. Probably no better subject for the study of insect structure and metamorphosis than the "Gelbrand" could have been selected. Not only is the Great Water-Beetle hardy and easily kept in captivity, with a comparatively rapid metamorphosis, but it illustrates remarkably well the specialisation of a primitive type in response to the special circumstances of its environment.

Vol. 1 deals with the skeletal system, its appendages and sense organs, and the nervous, muscular, respiratory and circulatory systems of both adult and larva. Vol. 2 completes the structural treatment with the consideration of the fat-bodies, and the alimentary and reproductive systems, passing on to development and metamorphosis and various aspects of its bionomics. Finally, there are two very interesting chapters on its early literature and systematics. After each chapter is given a very full bibliography for that particular part

of the subject. Both volumes are abundantly supplied with excellent illustrations.

Owing to unavoidable delay in the appearance of the work as a whole, it was felt that the results of certain pieces of research should be separately published in anticipation, so that some of the chapters in the complete work are practically reprints of papers previously published by Dr. Korschelt or his collaborators.

In view of the great attention to detail evidenced throughout the work, it is a little surprising to find no mention of the "pigment-spot" on the wings, an organ that has recently been claimed to serve a stridulatory function; neither, indeed, do we find any reference to the well-known stridulatory powers of the insect, and but the briefest mention of Finkler's experiments on the transplantation of the head from one individual to another.

An index would have facilitated reference, though its lack is to some extent compensated for by a very full list of chapter headings and subheads for each volume.

*A History of Bleaching.* By S. H. Higgins. Pp. viii+176+9 plates. (London: Longmans, Green and Co, 1924.) 10s. 6d. net.

AN investigation into the early history of any industry is of much interest, and may be of considerable value in throwing light on modern practice. Sometimes, as in the case of the bleaching of textiles, fairly detailed records of ancient processes are found, but it is not possible to compare the results obtained then and now, because a fabric bleached even one hundred years ago inevitably will have become more or less discoloured. On the other hand, there are many cases in which we can examine the results of ancient craftsmanship, but have no knowledge of the methods by which they were produced.

The demand for a "perfect" white on cotton, linen, and other textiles is comparatively modern. From an æsthetic view-point, the slightly brownish or greyish tint of white, which must have been the ultimate product of the bleacher before the introduction of chloride of lime, is more pleasing than the more luminous bleached white of to-day; which is probably the outcome partly of trade competition and partly of the requirements of some modern methods of textile printing.

The development of bleaching processes has taken place along two main lines, chemical and mechanical, and Mr. Higgins in his book traces the improvements due, in the first place, to the increase of chemical knowledge, and secondly, to the necessity of dealing with larger quantities of material. Chemical engineering received its early stimulus through the exigencies of the alkali industry and its offshoots, and thus early turned its attention to bleaching and the allied industry of calico printing; the mechanical developments in dyeing processes coming much later.

With the single exception of the introduction of bleaching powder about the beginning of the nineteenth century, there has been no fundamental change in bleaching processes since a very early period. The magnitude of the industry at the present time is indicated by the statement in the last paragraph of the book that about 2,000,000 miles of cloth are bleached

annually in Great Britain, a statement which may be approximately accurate if the amount of cloth which is partially bleached as a preliminary to dyeing or printing, is included. W. M. G.

*Liverpool Marine Biology Committee. L.M.B.C. Memoirs on Typical British Marine Plants and Animals.* 26: *Botryllus*. By E. Catherine Herdman. Pp. xi+40+6 plates. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1924.) 4s. 6d.

THE author of the present volume, on the compound Ascidian *Botryllus*, is a daughter and pupil of the late Sir William Herdman, who himself, twenty-five years ago, wrote a description of a simple ascidian as the first volume of the series to which this is the latest addition.

The editors of the series explain in a preface the interest attaching to *Botryllus*, and its advantages as a representative of the group to which it belongs. Miss Herdman's account, which follows, is carefully done, well arranged, clearly written, and excellently and fully illustrated by means of six plates, one of which is in colours. Besides the description of the anatomy, the author gives sections on embryology and development, and on the formation of the colony, as well as paragraphs on such subjects as coloration and the systematic position of the family. There are interesting references to the germ-layer theory in relation to the formation of the organs in the asexually produced blastozoids; to the mode of capture of the food particles; to the functions of the neural gland and dorsal tubercle; to the cause of the curious recurring alternations in the direction of the blood-flow; and to the special functions of the colonial vascular system. It is, however, to be regretted that in a book which the editors hope "will be found of value by students of biology in laboratories and in marine stations, and will be welcomed by many others working privately at marine natural history," the author has not included some account of the most suitable methods of examination.

*The Place of Partial Differential Equations in Mathematical Physics: Being a Course of Readership Lectures delivered at Patna University in 1921.* By Prof. Ganesh Prasad. Pp. iv+49. (Patna: Patna University, 1924.) n.p.

IN the six lectures before us, Prof. Prasad gives an interesting account of the part played by partial differential equations in dealing with vibratory phenomena, conduction of heat, gravitational attractions, electrostatics, magnetostatics, hydrodynamics, electrodynamics and the theory of electrons. Since D'Alembert's discovery in 1747 of the equation  $\ddot{y} = c^2 y''$  arising from the motion of a vibrating string, the study of natural phenomena by mathematical physicists has led them to certain standard types of differential equations. The essential difficulty in finding the solution of such a differential equation lies in fitting it to specified boundary conditions. If we have an initial stage of heat given by

$$f(x) = x \text{ for } x > 0, f(x) = -x \text{ for } x < 0,$$

the first and second differential coefficients are non-existent at the origin and the equation of linear conduction,  $\partial v / \partial t = \partial^2 v / \partial x^2$ , is meaningless there. An

unlimited number of similar cases can be constructed. Though partial differential equations are quite serviceable for most ordinary purposes, in a rigorous treatment they have to be relegated to a secondary place. It is quite possible that at some future time differential equations will appear as but crude instruments and be discarded in favour of the more powerful and more refined integral equations.

*Linear Integral Equations.* By Prof. W. V. Lovitt. Pp. xiii+253. (New York: McGraw-Hill Book Co., Inc.; London: McGraw Hill Publishing Co., Ltd., 1924.) 15s. net.

THE subject of integral equations has been much neglected in university teaching in Great Britain, partly because of the scarcity of text-books suited to the needs of the normal student of mathematics. In addition to a clear exposition of the theory, to carry conviction what the student requires above all is a number of particular examples and applications. The works of Bôcher (1909) in English, Volterra (1913) in French, and Kneser (1922) in German are available but are scarcely in general use.

Prof. Lovitt has produced a very readable book on this very important branch of mathematical study. The discussion, confined to those equations which are linear and in which a single integration occurs, does not deal with equations involving several independent variables, systems of integral equations or integro-differential equations. The author covers, however, in systematic manner the general theory of linear equations, exemplifying the points as they arise by a large number of particular cases and applying the methods to problems in differential equations, the calculus of variations, Neumann's and Dirichlet's problems, and to a series of cases of vibration. There is nothing very new in substance in the book, but it is eminently readable and very well produced.

*In the High Himalayas: Sport and Travel in the Rhotang and Baralacha; with some Notes on the Natural History of that Area.* By Hugh Whistler. Pp. 223+16 plates. (London: H. F. and G. Witherby, 1924.) 15s. net.

MR. WHISTLER'S book treats of sport and travel in a remote part of the Himalayan districts of the Punjab, Kulu, Lahul, and Spiti, of which the last is geographically part of Tibet though politically a district of India. The chapters dealing with it are of most interest since the country is almost unknown, but the whole book contains a great deal of valuable geographical and natural history material, including a chapter on birds. There are some fair illustrations and an adequate map.

*Ross and Cromarty.* By Prof. W. J. Watson. (Cambridge County Geographies.) Pp. xi+140. (Cambridge: At the University Press, 1924.) 3s. 6d.

PROF. WATSON has added a useful volume to the series of county geographies. The book is especially interesting on the human side, though with commendable restraint his section on the people, race, and dialect occupies only two and a half pages. We notice that he describes the Celts as members of the Nordic race, without actually using that term, and to this stock he attributes some of the fair-haired people of this highland area.

## Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

## Disintegration of Atomic Nuclei.

SINCE the discovery that high speed protons are emitted from the nuclei of a number of light elements by a close collision with an  $\alpha$  particle, it has been a matter of great interest to understand the mechanism of these collisions and particularly the fate of the bombarding  $\alpha$  particle. Dr. Chadwick and I have shown that the protons are emitted in all directions relative to the bombarding particles, but with greater velocity in the forward direction. This difference of velocity was ascribed to the effect of recoil of the nucleus, and assuming that the law of conservation of momentum, but not of energy, holds in such collisions, we were able to calculate from the experimental data the distribution of momentum between the particle, proton, and nucleus after the collision. These calculations showed that the velocity of the escaping  $\alpha$  particle was small for nitrogen, sodium, aluminium, and phosphorus, but considerable for boron and fluorine. Unfortunately, on account of the small number of particles, it is difficult to determine accurately the velocity of the proton in different directions, but, with accurate data, this method should prove useful in throwing light on the distribution of momentum amongst the particles concerned in the collision.

The number of collisions leading to the escape of the proton increases rapidly with the velocity of the impinging  $\alpha$  particle, and in the case of aluminium we could observe few, if any, protons when the bombarding  $\alpha$  particle had a range less than about 5 cm. The most direct method of studying the results of these collisions is to obtain actual photographs of the tracks of the particles by the well-known cloud method. From the data obtained from our investigations with nitrogen, it seemed probable that about one  $\alpha$  particle in 40,000 would liberate a proton when using a source of the swiftest  $\alpha$  rays available, namely, thorium-C, which emits particles of range 8.6 cm. in air.

The laborious task of photographing in two perpendicular directions the tracks of about 400,000  $\alpha$  particles was undertaken by Mr. Blackett in the Cavendish Laboratory, using a modification of Shimizu's method. The results of this investigation have been recently published in the Proc. Roy. Soc., 107, p. 349, 1925. In addition to a number of collisions of the  $\alpha$  particle with a nitrogen nucleus which obeyed the ordinary laws of an elastic collision, Blackett observed eight forks in all where these laws were not obeyed, and these he ascribed to collisions involving the liberation of a proton. The fine track of the proton was clearly visible, also that of the recoiling nucleus, but there was no sign of a third track to be expected if the  $\alpha$  particle escaped after the collision. He concluded that the  $\alpha$  particle is captured by the nitrogen nucleus under these conditions, and that in consequence the mass of the recoiling nucleus should be 17 and its charge 8—namely, an isotope of oxygen. He observed that the tracks were coplanar, indicating the conservation of momentum, and found the velocities of the proton and recoiling nucleus to be in fair accord with this assumption. Mr. Blackett hopes to examine in a similar way a number of other active elements to see if a similar process takes place.

It is not my intention here to discuss the bearing of these results on the mechanism of disintegration, but rather to direct attention to other results and suggestions in connexion with this important problem. In 1923, Prof. W. D. Harkins and R. W. Ryan (Journ. Amer. Chem. Soc., 45, p. 2095) photographed about 21,000  $\alpha$  ray tracks in air, using the Shimizu method, and amongst other observations recorded a photograph of a collision in which the  $\alpha$  ray track broke into three distinct branches—indicating a disintegration in which two high speed particles appear in addition to the recoiling nucleus. My attention has recently been directed to another interesting photograph in air by a similar method, recorded by M. Akiyama (Jap. Journ. Phys., 2, p. 272, 1923), which also shows three branches. The proton in this case is expelled nearly in the backward direction, and two other tracks ascribed to the escaping  $\alpha$  particle and recoiling nucleus are clearly visible. It is, of course, difficult to reconcile these photographs with the eight obtained by Blackett in which no third branch has been noted; but it may prove significant that the collisions photographed by Harkins and Akiyama appear to have occurred when the  $\alpha$  particle has lost a good deal of its range. It is obvious that there is still much work to be done to clear up these difficulties.

In view of the evidence obtained by Blackett of the capture of an  $\alpha$  particle, I have thought it of interest to bring to the attention of readers of NATURE two clear statements of the likelihood of such a capture in a collision which leads to the expulsion of a proton. In a discussion of a paper on the structure of the atom, read by me before the Solvay International Institute of Physics in 1921 (Rapports et Discussions du Conseil de Physique de Bruxelles, p. 68, published 1923), a reference to this question was made by Prof. J. Perrin. A selection of the remarks made by him will be given in full, as the above publication may not be generally accessible to readers of NATURE:

M. Perrin:— . . . "Les expériences mêmes de M. Rutherford semblent prouver qu'il faut renoncer à cette idée d'un simple choc. Le projectile  $\alpha$ , en raison de sa grande vitesse, et malgré une très forte répulsion électrique, peut arriver, très ralenti, au voisinage immédiat du noyau. A ce moment, une 'transmutation' se produit, consistant probablement en un réarrangement intranucléaire, avec capture possible du noyau  $\alpha$  incident (car nous ne savons pas ce qu'il devient), émission du noyau d'hydrogène formant le rayon H observé, et peut-être encore avec d'autres projections moins importantes. Il n'y a aucune raison, dans cette façon de voir, pour que le projectile H émis 'se souvienne' de la direction du choc initial ni pour que son énergie (empruntée pour une part à l'énergie électrique intranucléaire) soit inférieure à celle du projectile incident.

"Si, par exemple, le noyau d'aluminium heurté capture le projectile  $\alpha$  et n'émet pas d'électrons, il reste, après l'émission du projectile H, un atome dont la masse est  $(27 + 4 - 1)$ , soit 30, et dont le numéro d'ordre est  $(13 + 2 - 1)$ , soit 14, donc un atome isotope du silicium. D'autres hypothèses seraient d'ailleurs faciles."

A suggestion of a similar kind has also been made by Pettersson and Kirsch. They forwarded to me, in June 1924, a short paper intended for publication in which they gave a brief statement of preliminary experiments on the number and nature of the particles liberated from carbon and aluminium at an angle of about  $135^\circ$  with the bombarding  $\alpha$  particles. From these data they suggested that the  $\alpha$  particle might be captured in collisions in which the proton is liberated. A paper including a statement of their

views on this question was given at the *Versammlung Deutscher Naturforscher und Ärzte* at Innsbruck in August and published in the *Physikalische Zeitschrift* (25, No. 22, p. 588, 1924).

We must await the results of further detailed experiments to see how far such observations of scattering throw definite light on the problem of the mechanism of a disintegrating collision. It seems clear, however, that a large amount of careful quantitative work as well as a great number of photographs of  $\alpha$  ray tracks will be required before we can hope to obtain detailed evidence of the mechanism of such collisions and of the fate of the bombarding  $\alpha$  particle for all the "active" elements.

E. RUTHERFORD.

Cavendish Laboratory, Cambridge.

### The Source of Stellar Energy.

I AM glad to have drawn so interesting a letter from Prof. Eddington as appears in *NATURE* of March 21. I cannot, however, agree with him that the present position is one of "an almost hopeless deadlock," and neither do I agree with his criticisms of my scheme (*NATURE*, Feb. 28), by which a star consists of a mixture of different types of destructible matter which spontaneously dissolve into radiation at different rates, the rate in each case being unaffected by physical conditions of temperature and pressure. The process imagined by me was in fact analogous to radioactive decay except that the end product is radiation instead of other forms of matter.

Prof. Eddington considers that under this scheme the stars would be unstable. A star which in some way increased its rate of generation of energy would expand and this expansion would, he says, lessen the rate at which it was able to radiate its energy away. But why? The expanded configuration is not one of equilibrium and I cannot see that we have any knowledge as to the corresponding rate of radiation. *A priori* we would certainly expect that the star's first move, when it found too much radiant energy accumulating in its interior, would be in the direction of getting rid of more radiation, not less, as Prof. Eddington asserts. If so, Prof. Eddington's argument collapses entirely. It may be remarked that if the argument were sound and instability were proved, we could only restore stability by supposing that a decrease in a star's density and temperature decreased its spontaneous generation of energy, whereas in actual fact it is the stars of lowest density and of lowest internal temperature which radiate the most energetically.

My suggestion that when a star breaks up its ingredients are not fairly distributed between its constituent parts is criticised in the light of some conclusions Prof. Eddington has drawn from a certain recently published mathematical theorem. May I here merely state that in my opinion this theorem is entirely fallacious? I hope to justify this statement in print very shortly.

My scheme certainly requires "that the rate of emission of radiation by the star shall be very largely dependent on its previous history." In actual fact considerable ranges of luminosity are shown by stars of identical mass. These I should attribute to differences of birth and previous history, and it may be possible to infer something as to the past histories of the stars from these ranges. Prof. Eddington considers that the observed range is too small, but does he know enough of the past history of different stars to say how large a range ought to be expected? He discusses two hypothetical stars born originally with masses 12 and 3, but is there any reason for assuming

that stars can be born with so great a disparity of mass? I have, of course, to admit that in time a real difficulty may appear here, but at present its existence is not proven. To my mind the present difficulty lies in precisely the opposite direction; it is to account for the tendency towards equality of mass which appears in the two components of a binary as its evolution proceeds.

I find it difficult to understand the advantages of the hypothesis which Prof. Eddington offers as an alternative to mine. He supposes certain destructible types of matter to be formed at a rate which depends on temperature and density. Their rate of spontaneous dissolution does not depend on the temperature and density at the instant, so that the rate of generation of radiation depends only on the total amount of destructible matter present in the star, which in turn depends on all the temperatures and densities of the past. The radiation, in fact, represents a sort of integral of the past temperatures and densities. As regards stability his stars are in the same position as those of my scheme, while as regards dependence on past history they seem to be worse off.

Any variation, either of creation or destruction of matter, with temperature and density ought almost certainly to be in the direction of higher activity accompanying an increase of density and temperature, whereas in actual fact the (internally) hot dense stars radiate little and vice versa. If Prof. Eddington insists on any sort of dependence on density and temperature, he must not only, as he says, "admit exhaustion-effects also," but must actually admit more exhaustion-effects than are required by my own hypothesis—unless indeed he can prove that high temperature and density inhibit radiation.

J. H. JEANS.

March 23.

### Relation of Light to Bird Migration and Developmental Changes.

THAT light is a factor of prime importance in the inauguration or stimulation of bird migration, has been suggested by many authors from the days of Seebohm onwards. While many of the suggestions will not bear close investigation, at least one very attractive view has been put forward by Sir E. Sharpey-Schafer. In an address delivered some years ago to the Scottish Natural History Society<sup>1</sup> he makes the following comments, "... the regularity with which migration occurs, indicates that the exciting cause must be regular. There is no yearly change, outside the equatorial zone, that occurs so regularly in point of time as the change in the duration of daylight. On this ground this may well be considered a determining factor in migration, and it has the advantage over other suggested factors that it applies to the northerly as well as to the southerly movement." He says further "That it [migration] is a result of developmental changes in the sexual organs is improbable."

Evidently inspired by the work of the botanists Garner and Allard on what they have termed "photoperiodism," an American author<sup>2</sup> has lately revived this theory and has, apparently independently, come to the same conclusion as Sir Edward with regard to the absence of relation between developmental changes in the reproductive organs and migration.

On purely theoretical grounds it has always seemed to me that if the waxing and the waning of the days really in any way affect the migratory impulse, they must produce their effect through the gonads. This

<sup>1</sup> "On the Incidence of Daylight as a determining Factor in Bird Migration," E. A. Schafer, *NATURE*, vol. 77, pp. 159-163 (December 20, 1907).

<sup>2</sup> "Is Photoperiodism a Factor in the Migration of Birds?" G. E. Fernald, *Auk*, vol. 41, pp. 439-444.

is not the place for theoretical discussion, and I merely wish to record an experiment that has just reached completion. Other corroborative work is still in progress and a critical histological examination of the experimental and normal material yet remains to be undertaken.

In September of last year I trapped a number of Juncos (*Junco hyemalis*) on their southward migration to the Middle States. These were turned into two large open-air aviaries removed from shelter of any kind. One, into which about a dozen birds were put for the experimental work, was fitted with two 50-watt electric lights. The other housed controls. Commencing on October 2, the lights were turned on at sunset (that is, while the birds were still fully active) and kept on until five minutes after dark. Each day afterwards the time was lengthened by five minutes. Taking into consideration the differences in time of sunrise, the birds thus got about three minutes longer illumination daily. On account of the fact that they went to roost at their usual time on the first day in spite of the glaring lights, and that attempts at educating them to keep awake were never wholly successful, and less so with some individuals than with others, it has proved impossible to estimate the effective light increases. For the same reason there is lack of uniformity in the results obtained.

Elimination of the warmth factor was unexpectedly successful—thanks to a severe winter—the lowest temperature to which the birds were exposed being 50° below zero (Fahrenheit).

Birds were killed at intervals of approximately two weeks, with the following results:

Dates of Killing.	Number Examined.	Size of Testes. <sup>a</sup>
Oct. 15 (A wild bird killed same date)	1	0.50 × 0.48 0.60 × 0.60 <sup>4</sup>
Oct. 29	1	0.44 × 0.41
Nov. 13	1	0.45 × 0.53
Nov. 26	1	0.60 × 0.44
Dec. 11	1	0.80 × 0.79
Dec. 27 <sup>5</sup>	2	(A) 0.90 × ? (Part of ribbon destroyed) (B) 1.80 × 1.54

Catastrophe overtook my control birds and I had to find substitutes. Through the kindness of the Museum of Vertebrate Zoology, University of California, I have been receiving fixed gonads of Juncos (a closely related species of approximately the same size) wintering in the Berkeley district. These are not strictly comparable with mine, therefore, but the samples include birds taken at intervals from November to early January. In spite of the California climate, the January testes are minute. My solitary female, killed also on December 27, as compared with the early January females from Berkeley, has an ovary two to two and a half times as large and with conspicuous follicles.

The two males and the female killed on December 27 were kept indoors for their last week at an average temperature of about 40°. (Their drinking water froze one night.) The marked difference in the size of the testes of the two males may probably be accounted for by their habits. A went to roost, in

spite of the lights (the birds were together in the same cage) about an hour to an hour and a half each night before B. The female kept the latter company. A sang a good deal, B incessantly. All the birds were in excellent condition when killed.

It would, therefore, appear that whatever effect daily increases of illumination may or may not have on migration, they are conducive to developmental changes in the sexual organs. Comparison of the normal material from Riviera-like California with the experimental product from Alberta further suggests that favourable light conditions are more potent in this respect than favourable temperatures.

WILLIAM ROWAN.

11142 86th Ave., Edmonton, Alta.,  
Canada, January 28.

### The Mortality of Plaiice.

IT is most valuable to have Dr. Wallace's authoritative opinion (NATURE, March 7) that the scarcity in the North Sea of male plaice more than 8 years old is due to their own physiology and not merely to selective fishing. I suggest, however, to Dr. Wallace that this is no evidence of senile death, but of what we may conveniently call *parental* death. "The rapid decline in the relative number of males just after maturity" (the italics are Dr. Wallace's) indicates that death is a consequence of their last and most productive spawning, and Atkinson's Barents Sea Statistics (Table II.) seem explicable only if  $\frac{1}{2}$  of the males there die after first spawning. We know that fresh-water eels spawn once and die, the conger also (Cunningham, Journ. M.B.A., vol. 2, p. 31) spawns once and dies, and Child ("Senescence and Rejuvenescence," p. 302) states the same of the American salmon, adding, "the organism is undoubtedly in an advanced stage of senescence when sexual maturity is attained." Minot and Child, by the great importance of their work, have permanently changed the meaning of the word "senescence" to signify progressive diminution in rate of metabolism, and they have shown that "senescence" starts at a maximum in the dividing ovum and falls rapidly with advancing age. I would plead that "senility" be still left in its original meaning to designate the negative growth in man which begins after full sexual maturity, and the like phenomenon where it is found to occur in other organisms; so that we have terms in which it is possible to discuss whether "senility" be really merely the latter stage of "senescence." The death of a fish after spawning in the fulness of its power bears little resemblance to senile death, but is comparable to death of the spore-case when the spores are discharged, or of the wheat-stem when the grain is fallen; sexual reproduction primitively destroys the parent. The whole dividing protozoon disappears and the whole is utilised, but in metazoa a continually larger and more important somatic residue is wasted in death: in the conger, figures cited by Cunningham indicate that the heaviest roes approach to half the total weight, the residual body unutilised being therefore, at the lowest, equal in weight to the matricidal ovaries. So in many groups this loss of capital to the species is gradually avoided; the spent British salmon succeeds in returning to the sea and building up again in a year or two strength sufficient for a second spawning, the descendant of annual flowering plants takes on the biennial habit.

The hypothesis of potential immortality applies only to those plants and animals (of which, I still suggest, the female plaice may be one) which have completely lost the originally universal liability to parental death and have become perennial; and botanical

<sup>a</sup> The whole series of testes was sectioned at 6 $\mu$ . The first column indicates the greatest diameter of the largest section in each series in millimetres. The second is arrived at by adding the total number of sections for each series multiplied by 0.006.

<sup>4</sup> The testes of the bird on migration, had not yet reached the winter minimum and this accounts for their large size. Diminution in size during the initial stages of the experiment is very marked.

<sup>5</sup> A was an adult bird. B a bird of the year.

friends tell me that they know no evidence of senility in perennial root-stocks or 5000-year-old trees. My suggestion is that we have no evidence of senility in the female plaice, and that senility is not an inherent quality of protoplasm, but the consequence of a mechanism for the preservation of specific size. The plaice has no specific size, and therefore, when in the female growth is not ended by parental death, no mechanism for the limitation of growth is evolved and there is no senility.

Among animals which produce numerous young there is more reason for the female to attain the perennial habit than for the male, since a female plaice must grow for many years before she is large enough to produce as many ova as one eight-year-old male can fertilise. Even human curves of growth and senility indicate that in these aspects the male and the female are different animals. Looking at other groups, it becomes clear that no conclusion as to the gradient of life in one sex can be formed from observation of the incidence of death in the other: the queen-bee's life-history bears little relation to that of a drone; the longevity of the female spider is not measured by that of the consort she devours; and the female barnacle, *Scalpellum ornatum*, is associated with a succession of short-lived epizoic males.

I suggest to Dr. Wallace that we have as yet no evidence of senility in plaice, but of parental death for the North Sea male on perhaps the third spawning, at a body-weight of some 700 grams. There is an unproved possibility of parental death for the female on reaching some very much larger size at which her ovaries would bear a lethal ratio to her body-weight; this we may guess, on the analogy of the conger, might be when the ovaries form about one-half the total weight. If the ratio of ovary-weight to body-weight continue to increase according to the formula  $y = x^k/400$  (NATURE, January 31, p. 155), the ovaries would be one-half the weight when the plaice attains 6000 grams if  $k=1.61$ , and when it weighs 16,000 grams if  $k=1.55$ . (The largest plaice recorded, *vide* Cole and Johnstone, weighed 6800 grams.) If, on the other hand, as the fish grows larger  $k$  diminishes, and reaches 1.0 at a constant ratio of ovary-weight to body-weight which allows the residual body to recover after spawning, then the female plaice has lost liability to parental death, while it has assumed neither specific size nor the senile death which is its consequence.

GEO. P. BIDDER.

Cambridge, March 12.

### The Propagation of Radio Waves over the Earth.

IN NATURE of March 7 there are two letters dealing with the subject of the transmission of electric waves over the earth's surface. Prof. Appleton has given some results which indicate that very marked interference effects occur at night. So far as I understand, he has suggested an interpretation of the experimental results in terms of the simple theory in which the maxima and minima of received intensity are supposed due to the interference of a direct ray over the surface of the earth, and a single reflected ray, passing from the earth to the Heaviside layer and back to the receiver. But the problem is scarcely so simple as this, for the multiple reflection may occur, the ray passing many times between the earth and upper layer before reaching the receiver. Such an effect would obscure the main results if the intensity of these rays were of the same order as those of the direct ray.

About a year ago I made a mathematical investigation of the case, where the bounding surfaces are

assumed to be plane; the results obtained are of interest in connexion with the present problem.

Very briefly, the electric force at the receiver due to a current  $I$  in a transmitter of effective height ( $h$ ) situated on the lower of the two surfaces consists of the direct wave:

$$i.e. \quad \frac{120\pi h I}{\lambda x} \cos \left( \frac{2\pi}{\lambda} x - pt \right),$$

together with a finite number  $s$  of terms of the form

$$\frac{120\pi h I \sqrt{1 - \beta_m^2}}{2H \sqrt{\lambda x}} \cdot \cos \left( \frac{2\pi x}{\lambda} \sqrt{1 - \beta_m^2} - pt + \frac{\pi}{4} \right),$$

where  $s$  is the nearest integer less than  $2H/\lambda$ , and  $H$  is the height of the layer,  $\lambda$  the wave-length of the transmitted wave,  $x$  the distance, and

$$\beta_m = \frac{(s - m)\lambda}{2H},$$

$m$  being an integer which varies from zero up to  $s$ . These terms represent a series of progressive waves which travel to and fro between the upper and lower surfaces along rays which are inclined at angles  $\theta_m$  to the earth's surface where  $\sin \theta_m = \beta_m$ .

Together with these there are a series of stationary wave terms which are unimportant compared with the progressive waves at distances large compared with the height of the Heaviside layer.

The effect of resistance in the bounding layers is to introduce an attenuation factor in each of these terms of the form  $E^{-\alpha x/\sqrt{\lambda}}$  and to modify the intensity only to a second order amount.

The state of affairs in the space between the two layers is very complex, especially when a wave-length is used which is very small compared with the height. The object of this letter is to point out the conditions under which the simple theory is applicable, and also to show how these mathematical results may be used to determine the height of the Heaviside layer in the daytime, a determination which is beyond the scope of Prof. Appleton's experiment, since the interference effects with which he deals do not occur in the daytime.

With regard to the first question, I agree with Prof. Appleton that there is evidence that the bounding surface of the upper conducting layer is not sharply defined, and that there must be a more or less gradual transition. This would favour the reflection at glancing incidence compared with that at normal or nearly normal incidence.

If, then, the receiver were fairly close to the transmitter so that the distance between them were of the same order as  $H$ , multiple reflections might not occur, and the results might be explained by the simple theory; but the fact that fading effects as well as directional variations have been observed so close as twenty miles from the transmitter, shows that high angle reflections must not be entirely neglected. Experiments must decide whether they are or are not of importance in Prof. Appleton's case.

With regard to daytime transmission, I think that in spite of the fact that there are no signs of interference phenomena, transmission on long wave-lengths, and as recently shown, on very short wave-lengths, must be effected by the help of an upper layer, which for long waves acts as a pure conductor and for very short waves as a refracting medium with ionic dispersion.

This view is upheld by the results of a large number of measurements made during the past three years, the results of which will be published shortly in a paper before the Institution of Electrical Engineers. These indicate that for transmission on waves longer than

about 5000 metres, diffraction alone is wholly inadequate to account for the signals obtained.

If now we assume the presence of some reflecting or refracting layer, the foregoing mathematical theory can be applied at a distance large compared with  $H$ , but small relatively to the earth's radius, so that the curvature can be neglected.

In actual practice the interference between the large number of terms postulated by the theory is not present, and this may be accounted for by assuming that the layer is a good reflector only for glancing incidence; in this case it can be shown that only the zero order term remains (with  $m = s$ ,  $\beta_s = 0$ ),

$$i.e. \quad \frac{120\pi h I}{2H\sqrt{\lambda x}} E - \alpha x / \sqrt{\lambda}$$

apart from the direct wave, which, varying inversely as the distance, is negligible at greater distances than a few hundred kilometres.

Now the experimental results show that the observed signal strength  $E$  can be expressed very well by a formula of this type in which the value of  $H$  is approximately 40 km. This must be regarded as only an equivalent value since the lower surface of the layer is probably very ill-defined. T. L. ECKERSLEY.

Marconi's Wireless Telegraph Co., Ltd.,  
Chelmsford, March 20.

### The Absorption of Cathode Rays in Aluminium.

In a recent paper in the *Physical Review* (December 1924), H. M. Terrill gives some measurements of the variation in the fraction of a beam of cathode rays transmitted by an aluminium foil when the velocity of the rays is varied. These results are not in agreement with those published by me (Proc. Roy. Soc. A, vol. 104, 1923); and the author states that "Whiddington, and later Schonland, worked with rays of uniform velocity produced by magnetic sorting, but the results obtained by them are not in agreement with each other nor with those of the earlier writers. It is believed that the lack of agreement in these results may be traced to the difficulties of velocity determination."

This is scarcely correct. A variety of causes rendered the work of the earlier writers unsatisfactory from a quantitative point of view, while the experiments of Whiddington suffered from an important defect, for no precautions were taken against the disturbing effect of the emission of secondary rays from the foil. My apparatus was designed to remove this source of error, and when allowance is made for the secondary emission, Whiddington's results are in satisfactory agreement with my own.

Dr. Terrill's explanation of the difference between his results and mine would require a correction to my values of  $H\rho$  amounting to about 20 per cent., while I am certain that they are not at fault by more than 2 per cent., the measurements having been repeated with a new and differently wound solenoid.

That the difference is, however, not due to this cause at all but to the experimental arrangement for measuring the fraction transmitted, is shown by the fact that our results for the velocity of those rays which are just unable to penetrate the foil (the "Range" velocity) are in close agreement. Thus, for a foil 0.00031 cm. thick he finds 19,000 volts, and I, 19,500 volts for the P.D. corresponding to this velocity. This indicates that my velocity measurements are substantially correct and that the differences between our results arise from errors in the measurement of the fraction transmitted.

I believe that Dr. Terrill's arrangement for this purpose is open to criticism, principally owing to

the method adopted to prevent the emission of secondary rays from the foil, but also to the fact that so small a fraction ( $< 1/1000$ ) of the cathode ray beam was employed in the actual measurements. I have had experience of both these causes of error and found them to be very serious.

B. F. J. SCHONLAND.

University of Cape Town,  
February 18.

### Adsorption of Acids by Purified Silica.

IN the issue of NATURE for January 31, p. 157, it has been stated that hydrated silica free from all impurities adsorbs acids. The amounts adsorbed by these samples are, however, small. We have since found that if thoroughly washed hydrated silica prepared from pure silicon tetrachloride be allowed to be partially dehydrated in air at room temperature, it shows a marked increase in its capacity to adsorb acids, as the following data will show:

Electrolyte.	Concentration.	Amount of Adsorption per 10 c.c. of solution
Oxalic acid . . . .	$\left\{ \begin{array}{l} N/2 \\ N/10 \\ N/50 \end{array} \right.$	46.0 c.c. of N/10 solution 7.5 " " " 1.0 " " "
Potassium oxalate . . . .	$\left\{ \begin{array}{l} N/2 \\ N/10 \\ N/50 \end{array} \right.$	45.0 " " " 7.5 " " " 1.0 " " "
Sodium oxalate . . . .	$\left\{ \begin{array}{l} N/10 \\ N/50 \end{array} \right.$	7.5 " " " 1.0 " " "
Hydrochloric acid . . . .	$N/2$ (F 1.08)	42.0 " " "

The samples are free from all impurities. At equivalent concentrations, neutral oxalates and oxalic acid show equal adsorption of the oxalate ion, which, together with the increase in the negative charge of the silica in contact with solutions of neutral salts of low concentrations, proves that we are dealing with anion adsorption as suggested by the writer to account for the latent acidity of sour soils. The large amounts of acids adsorbed leave no doubt that Joseph and Hancock were mistaken in stating that purified silica cannot adsorb acids. That they could not observe any adsorption of acids by silica was due to their using ignited silica, as we have found that on ignition the power of silica to adsorb acids greatly diminishes.

In my previous letter referred to above, a mistake occurs (page 158) in the  $P_H$  value for the acidity developed on interaction between barium chloride and potassium sulphate. The value given was 2, whereas it should have been 5.

J. N. MUKHERJEE.

University College of Science,  
Calcutta.

### Method of Measuring Deep Sea Tides.

IN the course of a conversation with William Beebe regarding plans for work to be done on his oceanic expedition, my attention was directed to the fact that no method had been devised up to the present time for recording the rise and fall of the tides except in comparatively shallow waters. It appeared that the Hydrographic Office was very anxious to have data regarding the tides at localities where the depth of the ocean was measured in miles.

The problem looked rather hopeless at first sight, but on thinking about it, the idea occurred to me that if we could make an artificial island, reaching up from the sea floor to within a few feet of the surface, the rest would be easy. Such an island could be made by means of a submerged buoy

anchored to the sea bottom by a wire. If the ocean were calm, and there were no currents, this buoy would remain in a fixed vertical position above its cement anchor at a constant distance from the ocean floor. If the buoy contained a self-recording barograph of special design operated by the pressure of the water above the buoy, the periodic rise and fall of the tide would be recorded.

Other factors might, and probably would, be present which would cause a variation in the height of the water above the buoy. Ocean currents, by causing the buoy to swing out from the vertical, would depress it, and there would of course be a rapid periodic change due to waves. It seems probable, however, that if the curve drawn on the revolving drum of the barograph was subjected to analysis by passing it through such a machine as Prof. Michelson's harmonic analyser, the tide curve would come out uncontaminated by the variations contributed in other ways.

The scheme could be tried at very small cost. The first experiments should be made in comparatively shallow water (say three or four hundred feet), and the depth gradually increased. For deep sea work the position of the submerged buoy would have to be marked by a smaller surface buoy. The action of the wind on this would introduce another disturbing factor, which would disappear, however, in the analysis of the curve.

R. W. WOOD.

Johns Hopkins University, Baltimore.

#### Electricity in Curved Space-time.

It is often thought that the theory of curved space-time (general relativity theory) accounts for gravitation but *does not account for the electromagnetic phenomena*. This is not so.

In the general four-dimensional space, the Riemann tensor which characterises the curvature at each point can be shown to be the sum of two parts. We may characterise these two parts geometrically, using Hamilton's device of telling what a thing is by telling what it does. What a Riemann tensor does is to assign to every two-dimensional direction, or orientation, a certain number—its curvature; the first of the two parts mentioned above is characterised by the property that it assigns to two (absolutely) perpendicular orientations *equal* curvatures, while the second part assigns to such orientations *opposite* curvatures. We may mention that of the twenty constants which are needed to give the complete Riemann tensor, the first part involves 11 and the second 9.

In the case of the physical space-time, the first part accounts for gravitational phenomena and the second for electromagnetic. We do not know much about the first part outside the fact that it satisfies the so-called cosmological equations (in fact, to say that a Riemann tensor satisfies the cosmological equations is equivalent to the statement that it only consists of the first part). Our information with respect to the second part is much more complete: if  $f_{\mu\nu}$  is the electromagnetic tensor and  $r_{\mu\nu}$  the tensor associated with its reciprocal or dual, the second part can be written as  $\frac{1}{2}(f_{\mu\nu}f_{\kappa\rho} - r_{\mu\nu}r_{\kappa\rho})$ ; conversely, if the second part is given in a region of space-time, this determines the electromagnetic tensor in this region. This result follows easily from an earlier work of the writer (Proc. Nat. Acad. of Sciences, April and July 1924, Trans. Amer. Math. Soc., January 1925).

G. Y. RAINICH.

The Johns Hopkins University,  
Baltimore, Md., U.S.A.,  
February 20.

NO. 2892, VOL. 115]

#### Artificial Incubation.

IN the account of Mr. Llewelyn B. Atkinson's article on "The Scientific Principles of Artificial Incubation" (NATURE, February 21, p. 282), the author is quoted as saying that practically every type of incubator has the air too dry. If this is so, the number of eggs hatched should be dependent to some extent on the humidity of the outside air. That this is the case is we think borne out by the following. We took the percentages of fertile eggs hatched out at Fishponds Poultry Farm, Netley Abbey, and correlated the figures with the relative humidity deduced from the dry and wet bulb readings at Calshot, four and a half miles distant. The hatchings considered were from December 17, 1923, to March 12, 1924; there were hatchings on 26 days; the largest number of eggs hatched out on any one day was 95, the smallest two 37 and 60; the highest percentage of fertile eggs hatched on any one day was 93.2, the lowest 63.5. The readings at Calshot are those taken four times in the twenty-four hours, and we have taken them from the Daily Weather Report. The following values were found for the correlation coefficient between the percentages of hatchings and the mean relative humidity for various periods:

	Day of Hatching.	7 Previous Days.	14 Previous Days.	21 Previous Days.
Correlation coefficient .	0.31	0.55	0.60	0.68
Standard error .	0.18	0.14	0.10	0.11

It seems, therefore, that the hatchings were dependent to some extent on the mean relative humidity of the outside air during the greater part of the period of incubation.

C. J. P. CAVI.

T. VERNON JONES.

Stoner Hill, Petersfield,  
March 12.

#### Solutrean Art.

PROF. SOLLAS, in his letter to NATURE, March 21, p. 420, refers to M. Peyrony's interesting discovery of a carving in high relief in a Solutrean level in the Dordogne. In this connexion it is worth noting that, some months before M. Peyrony's discovery, Dr. Henri Martin had found fragments of limestone bearing engravings of animals in an Upper Solutrean site (still unpublished) in the Charente.

These two finds, so nearly simultaneous, are very important, as Prof. Sollas points out, but it is only fair to recall the fact, apparently overlooked both by M. Peyrony and Dr. Martin, that the credit of being the first to find a work of art in an undoubted Solutrean milieu belongs, not to either of them, but to the Abbé A. and J. Bouyssonie and L. Bardon, who in 1908 found in the Upper Solutrean level of the rock-shelter Pré-Aubert near Brive a slab of sandstone engraved with the rough but unmistakable figure of a horse (*Revue anthropologique*, 1920, p. 188.)

At a moment when discoveries of Solutrean art are exciting great interest both in Great Britain and in France, it is merely just that full credit should be given to the three indefatigable scientists whose work, so little advertised, has been of such fundamental importance to prehistoric archaeology.

D. A. E. GARRON.

85 Banbury Rd.,  
Oxford.

Mutation.<sup>1</sup>

By Prof. R. RUGGLES GATES.

THE term mutation in the modern sense means a discontinuous germinal change. Conceptions of continuity or discontinuity have played an important rôle in the history of thought not only in biology, but also in other sciences, notably physics and geology. In the latter science the earlier and cruder theories of catastrophism, in which the sudden extinction of floras and faunas was followed by the creation of new ones, were superseded by the uniformitarianism of Lyell. This, coupled with the slow and gradual modification of species as upheld by Darwin, led to a complete triumph of "continuity." But with the followers of Darwin it frequently reached an extreme expression which was not in accordance with the facts of biological variation. It was thought that variations which were often spoken of as infinitesimal, could be accumulated in any direction to produce new species. But to produce a new species by this method, such accumulation of infinitesimals must take place simultaneously in several diverse directions, for species differ from each other in a number of independent characters.

Neither Darwin himself nor Wallace ever contemplated infinitesimal variations as a source of new species. Darwin was at pains to show that the gaps between species or varieties could frequently be bridged by intermediate steps, but he was too widely observant of actual variations in plants and animals to make the mistake of assuming complete continuity in all variation. The innumerable cases of variation which he cites in the "Origin" and the "Animals and Plants" usually concern differences which are relatively large compared with many which we now cite and study as discontinuities. The mutations of *Drosophila*, for example, such as the eye colour series, represent differences which are smaller than anything upon which Darwin relied for the origin of new forms. When all these eye colours are placed together they represent so close a series that to the average naturalist they appear to show complete continuity even under the microscope; and even the expert can scarcely sort all the individuals belonging to the different types in this series with certainty. Yet we know that they arise as marked discontinuities and not as steps in a consecutive series. They are moreover independently inherited, belonging often to quite independent groups of characters.

Biological controversy on this subject has oscillated somewhat like a pendulum gradually coming to rest. Each time the upholders of continuity have pointed out an apparently continuous series, their opponents have replied by showing progressively smaller discontinuities within the series. Waagen, Korschinsky, Bateson, W. B. Scott, de Vries, Morgan and others have taken part in this controversy.

Continuity or discontinuity is then a purely relative matter. Series of variations which Darwin and his contemporaries would have regarded as showing complete continuity biologists of this generation have shown by breeding experiments to be inherited as independent units. The essential point is not whether the series appears continuous or not, but whether the

differences depend on fixed inherited units. Two series of variations may overlap so as to appear like a single continuous series and yet may depend upon two independent units of inheritance.

When we touch modern physics discontinuity appears everywhere. To the senses matter is continuous, but no scientific man doubts the atomic and molecular, that is, the discontinuous, structure of matter. The atom itself, once regarded as an ultimate unit, is now decomposed into electrons with definite orbits revolving about a nucleus, the analysis of which into protons and electrons has only just begun. Planck's theory of quanta of energy or action extends discontinuity from matter into the field of energetics, and even radiation is now considered as a discontinuous process. Sir Oliver Lodge, in his presidential address to the British Association at Birmingham in 1913, said, "So far from nature not making jumps, it becomes doubtful if she does anything else." Even the ether of space is not retained as a continuum to serve as a background for these physical events. It cannot be adequately used in physical theory except by giving it a granular, that is, a discontinuous structure.

I refer to these similarities in the history of physics and biology, to show that discontinuity is a philosophical necessity in scientific analysis. The mere process of analysis of any structure, however large or small, whether it be a star, a chromosome or an atom, endows it with parts which have relations with each other and are more or less disconnected.

The real problem for the biologist is, then, to determine whether his units in the study of variation are rightly chosen, so that the laws of their inheritance can be followed. In the modern point of view, variations are of two sorts: (1) mutations, which form a new point of departure and are inherited, and (2) fluctuations, which are merely deviations grouped on either side of the mean, produced by environmental or nutritional disturbances and not inherited. This distinction we owe to de Vries, whose "Mutation Theory," first published in 1901, marked, together with the rediscovery of Mendelism, the beginning of a new era in the study of evolution.

Before outlining the theory of mutation, in the later development of which my own work has played some part, I wish to refer briefly to a few of the earlier observations and theories of discontinuity in variation. The earliest actual mutation recorded is that of *Chelidonium laciniatum* Miller, a subspecies derived from *C. majus* Linn. the common celandine, a monotypic genus of the poppy family. This laciniate variety was found by an apothecary named Sprenger growing in his herb garden at Heidelberg, about 1590, among typical plants. It was new and unknown to the botanists of his time; it bred true from seeds and has continued to do so ever since. It differs from the type in having laciniate petals and leaves. Such variations are by no means uncommon, the cut-leaved varieties of many trees such as the birch, etc., being of this character.

We need not pause here to consider whether the lacination first arose at the time when it became

<sup>1</sup> From a lecture delivered at King's College, University of London, for the Board of Studies on the History, Principles and Methods of Science.

externally visible or whether it had been carried germinally as a recessive condition for some previous time. Nor need we probe here the question whether the germinal change involved arose in a pure line or in a line the ancestors of which had been derived from the intercrossing of distinct types within the species. Something distinct and new has declared itself, and we call it a mutation, recognising that further analysis will throw much light on the precise manner of its origin, that is, the nature of the germinal change involved.

The conception of discontinuity in evolution did not originate with de Vries, although he was the first to investigate it by experimental methods. Without tracing its sources in biology, its modern emphasis began with Bateson, whose "Materials for the Study of Variation," in 1894, marked a reaction from the morphological problems then current in zoology and from the post-Darwinian attempts to explain evolution entirely through the accumulation of infinitesimal variations by natural selection. Bateson's subsequent development of Mendelian theory has been a continuation of views there set forth.

Another work which had an important effect, especially on botanical thought, was the "Intracellular Pangenesis" of de Vries, first published in 1889. The views there expressed were themselves derived from the development and modification of Darwin's provisional hypothesis of pangenesis, set forth in the last chapter but one of the "Variation of Animals and Plants under Domestication." This hypothesis of representative particles or gemmules assumed that every cell of the body is represented by particles which multiply by division as the organism develops. These particles (1) not only grow and multiply and are thrown off from the cells, but (2) they "aggregate themselves into buds and the sexual elements," by this means transmitting their qualities to the next generation. The hypothesis of de Vries discarded the second part of Darwin's hypothesis (which Darwin had introduced to account for the assumed inheritance of acquired characters) while limiting the first part, so that pangens were not extruded from the cells but controlled the development of a cell by passing from its nucleus into the surrounding cytoplasm.

Both Strasburger in cytology and Pfeffer in plant physiology adopted the term and the conception. The necessity for some such conception to account for the phenomena of development and heredity has been felt by many other physiologists, such as Verworn with his biogens. Physiologists who deny the necessity for such a conception have not occupied themselves seriously with the study of heredity. Chromosome division in mitosis must itself be looked upon as an hereditary process—an essential act of reproduction—and the chromosome as a body composed of autogenetic substances which show alternately the phenomena of growth or multiplication and division. The chromosome, as the most conservative body in the cell, thus makes possible the phenomena of heredity. The autogenetic particles which it is assumed to contain tend with increasing knowledge to lose their "representative" character and to become more purely chemical aggregations.

The whole history of the many conceptions of biological units furnishes but another example of the necessity for discontinuity in scientific analysis. The

modern gene or factor, which is essential to the explanation of Mendelian heredity and mutation, is the same particle under another guise, the properties and modes of action of which are gradually becoming more precisely defined. Each such gene may have come into existence through the alteration of a previous element, and not necessarily through the loss or gain of a "particle." The philosophical necessity which Darwin himself felt, and which was the *raison d'être* of his hypothesis of pangenesis, has been followed by a long historical chain of representative particles, such as the ids and biophores of Weismann, down to the modern gene, which has been stripped of some of its mystery but is still essential for an explanation of the phenomena of heredity and variation.

In the original work of de Vries with *Oenothera Lamarckiana*, a number of new forms or mutations were described as arising, which usually differed from the parent in a number of features. Later cytological investigations, beginning in 1906, made it clear that the origin of many of these new types was concerned with changes in the number of chromosomes. This finally led to the formulation of the cell theory of mutation,<sup>2</sup> in which it was indicated that Mendelian mutants, such as *Oe. brevistylis* and *Oe. rubricalyx*, had arisen as the result of a change in one element or gene of a chromosome, while such mutants as *lata* and *incurvata*, which possessed an extra chromosome, had appeared in connexion with an irregular reduction division of the chromosomes in the parent. Since the extra chromosome was found in every cell nucleus, the conclusion was clear that a mutation represented a germinal change which was transmitted by mitosis to every cell. This point of view has been strengthened by many subsequent discoveries. A whole series of *Oenothera* mutations with 15 chromosomes is now known.<sup>3</sup>

The origin of the mutant *Oe. gigas* involved still a different type of germinal change, for in this case the chromosome number was doubled (28). This was the first instance in which tetraploidy was shown to occur under experimental conditions. *Oe. gigas* is so distinct from *Oe. Lamarckiana* in all its characters that if found wild it would undoubtedly be described by systematists as a new species. There is even a conspicuous change in the shape of the pollen grains. Polyploidy, or the multiplication of the chromosome series, is now known to have played a part in the evolution of many plant genera.<sup>4</sup>

Another conception based upon the discoveries with *Oenothera* is that of parallel mutations. It was shown originally in 1912 that *Oe. biennis* can produce a *lata* mutation having the foliage peculiarities, sterile pollen and 15 chromosomes of the *lata* derived from *Oe. Lamarckiana*, but having the small flowers of its parent *Oe. biennis*. Innumerable cases of such parallel mutations are now known,<sup>5</sup> and the principle is bound to play an important part in the future interpretation of phylogenies.

Many other developments in the theory of mutation have occurred since 1901. The experimental work with Mendelism and mutations has shown that these two fields of research are fundamentally in harmony and can be further developed under a common point of view.

<sup>2</sup> Gates, "The Mutation Factor in Evolution," 1915.

<sup>3</sup> Gates, "The Trisomic Mutations of *Oenothera*," *Ann. of Bot.*, N.S., 17, p. 543, 1924.

<sup>4</sup> "Polyploidy" *Brit. Journ. Exptl. Biol.*, 1, 153-182, 1923.

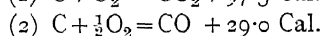
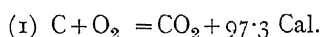
<sup>5</sup> See for example Gates, "Mutations and Evolution," 1921.

## The Manufacture of Blue Water Gas.

THE manufacture of water gas first became an industrial proposition in 1873 with the introduction of the intermittent system by Strong and by Lowe in the United States. Strong, who aimed at manufacturing blue water gas mainly for heating purposes, utilised the heat value of the "blow" gases to super-heat the steam admitted to the generator. Lowe, on the other hand, aimed at producing a gas of high illuminating value, and utilised the large quantities of combustible gas produced during the "blow" periods for heating chambers in which enriching oil was decomposed. No real progress in the manufacture of water gas in Great Britain was made until 1888, when a plant was installed at the Leeds Forge. Since that time the utilisation of water gas has advanced rapidly, and the manufacture of water gas, both blue and carburetted, is now an important auxiliary in the production of gas for town supply.

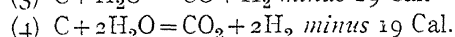
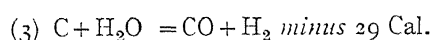
The blue water gas process, according to general British practice, may conveniently be divided into two distinct operations. The hot fuel, usually coke, is first raised to a high temperature by the admission of air at such velocity that the pressure below the generator grate is 12 to 18 inches water-gauge. This operation, known as the "blow," occupies from one to three minutes. The gases produced are blown away to the atmosphere through the stack, either directly or after combination with air and passage through a waste heat boiler. When the temperature of the coke has been raised to the required degree, the air supply is closed, and the bed of fuel is submitted to the action of steam supplied at a measured rate. The steaming operation, which is known as the "run," occupies from four to ten minutes according to the cycle of operations adopted. The blow and run operations are carried out alternately during a period of several hours, at the end of which the operations are suspended for the removal of ash unless mechanical grates are provided.

**BLOW PERIOD.**—The addition of heat to the bed of fuel during the blow period results mainly from that developed by the oxidation of carbon to carbon monoxide and carbon dioxide, and provided other conditions remained unchanged, the degree of heat addition would be dependent on the proportion in which these two gases are produced. The principal reactions which take place may be represented by the equations:



The aim during the air-blow should therefore be to obtain the maximum amount of carbon dioxide and the minimum of carbon monoxide. The first reaction predominates at lower temperatures and the second at higher temperatures. The efficiency of heat generation therefore decreases with rise of temperature.

**RUN PERIOD.**—When steam is passed over incandescent coke, of the reactions which occur, consideration should be given to the following:



NO. 2892, VOL. 115]

At temperatures above 1000° C., the products of reaction of steam and carbon are almost entirely carbon monoxide and hydrogen. At lower temperatures the importance of reaction (4) increases, and the proportion of steam decomposed decreases.

From consideration of the reactions which take place in the intermittent process of manufacture of water gas, it is clear that in order to obtain high efficiency of heat addition during the air-blow, the fuel must be kept at a comparatively low temperature, and the time of contact of the gases with the hot fuel must be small. On the other hand, to obtain a high efficiency during the steaming operation, the fuel should be kept at a high temperature, and a longer time of contact must be allowed. It is evident, therefore, that these opposing factors must be taken into account in determining the conditions of best efficiency for the whole process.

During recent years, the large scale production of water gas has been the subject of investigations by a Research Committee of the University of Leeds and the Institution of Gas Engineers, and by the Fuel Research Board. From the data procured, thermal balances were constructed. As an example of a thermal balance under conditions typical of British practice, the following is taken from the tenth report of the Research Committee of the Institution of Gas Engineers:

HEAT BALANCES IN THERMS PER 1000<sup>3</sup> CUB. FT.  
WATER GAS MADE.

Heat supplied—

(a) Coke to generator . . . . .	4.900
(b) Fuel to raise steam to generator . . . . .	0.551
(c) " " " " turbine . . . . .	0.643
(d) Sensible heat of air to blower . . . . . Minus	0.001
	<hr/>
	6.093
	<hr/>

Accounted for as follows—

1. Water gas, potential heat . . . . .	2.960
2. " " sensible heat . . . . .	0.171
3. Steam not decomposed (total heat) . . . . .	0.163
4. Blow gas, potential heat . . . . .	1.042
5. " " sensible heat . . . . .	0.462
6. Heat lost in raising steam to generator . . . . .	0.165
7. " " " " turbine . . . . .	0.193
8. Heat of steam used and lost in turbine and blower . . . . .	0.446
9. Ashes, potential heat . . . . .	0.207
10. Clunker " " . . . . .	0.017
11. Dust " " . . . . .	0.070
12. Ashes, clinker, and dust, sensible heat . . . . .	0.020
13. Losses, not separately determined, leakages, radiation, convection, etc. (difference) . . . . .	0.177
	<hr/>
	6.093
	<hr/>

In a paper presented a short time ago to the Institution of Chemical Engineers, Dr. M. W. Travers has studied the results of the investigations previously mentioned. Dr. Travers is of the opinion that in addition to thermal balances of the type illustrated, thermal accounts should be constructed to show the amounts of heat added to the fuel during the blow periods and abstracted during the steaming operations. These two amounts of heat should be identical provided that the whole of the necessary data is available with a high

degree of accuracy. The problem, however, is complex, and many other factors in addition to the main carbon-oxygen and carbon-steam reactions must be considered. The coke supplied to the generator invariably contains moisture, hydrogen, sulphur, nitrogen, and ash, and these constituents take part in a number of reactions which cannot be neglected. The amount of water

vapour in the air supplied to the generator also has an important effect on the heat account. Separate thermal accounts for the "blow" and "run" periods would undoubtedly be of value, but further study of the subject is required before these can be constructed with sufficient accuracy to enable trustworthy conclusions to be drawn.

A. PARKER.

### Obituary.

PROF. AXEL WIRÉN.

THE death of Prof. Axel Wirén of Upsala has deprived zoology of an able original worker and a distinguished teacher in the University of Upsala. Born on July 12, 1860, in Eskilstuna on the western or landward side of the province of Söderman Land, about 50 miles west of Stockholm, and the eastern border of which (province) reached the sea, Wirén received his early education at the school of Norrköping, in which his matriculation examination also took place, and he afterwards entered the University of Upsala, where he graduated as Ph.D. in 1885, his thesis being on the circulatory and digestive organs of certain families of polychæts.

From the first the young graduate was attracted to marine zoology and at a time when several departments were sorely in need of scientific advancement. He set himself to work up the zoology of Upsala, especially the chætopods, and by and by he published a series of important researches in the Kongl. Svensk. Vetensk.-Akad. Handl., all finely illustrated by his artistic pencil, the plates varying in number from 5 to 10 (4to) in each communication. The accuracy and beauty of these plates and the value of the accompanying researches would alone have given him a solid reputation. They dealt chiefly with the circulatory and digestive organs of the polychæts, though the minute anatomy of the solenogastres was also worked out with conspicuous ability. Amongst his interesting novelties was the discovery of *Hæmato-deptis terebellidis*, a parasitic eunicid living in the wall of the chitinous stomach of *Terebellides Strœmi*—just as Spengel had found another polychæt, *Oligonathus Bonellie*, in the coelom of *Bonellia*. Besides other papers he published one on *Nereilepas fucata* in its atokous and its epitokous forms, and the changes in its body-wall, as well as a work on the elements of zoology, a useful treatise for his students. He also gave an account of a visit he made to the museums and zoological institutes of Germany in 1891.

Besides his own strenuous labours in upholding zoology at Upsala—mindful of his responsibilities—Wirén encouraged the young graduates and others to carry on original work in his department, and exerted himself in founding the zoological institute of the University from which many important memoirs were issued. These were published in the series of the "Zoologiska Bidrag från Uppsala" (large 8vo), edited by Prof. Wirén. The perusal of these fine memoirs (the expense of which was partly defrayed by the generosity of the late consul, R. Bünsow) raises a feeling of regret that, in a great country like Britain, zoological institutes on the sea beach should be closed for lack of men, interest, and money, instead of continuing the fascinating researches in marine zoology

and botany—not to allude to the importance of these in connexion with the fisheries.

Prof. Wirén was elected to the chair of comparative anatomy at Upsala in 1893, after holding various minor posts. He became professor of zoology and Director of the Zoological Institute in 1908, and held these offices until his death on January 22 last. He worthily served his country and science.

W. C. McINTOSH.

MR. W. H. FINLAY.

A CORRESPONDENT at Cape Town sends us some particulars of the life and work of Mr. William Henry Finlay, formerly chief assistant in the Royal Observatory, Cape Town, who died there on December 7, 1924. Mr. Finlay was born at Liverpool on June 17, 1849, and educated at Liverpool College School. He proceeded to Trinity College, Cambridge, graduating 33rd Wrangler in 1873. In the same year he was appointed first assistant at the Cape Observatory, when Mr. Stone, who succeeded Sir Thomas Maclear, was H.M. Astronomer. Mr. Stone's directorate is chiefly remarkable for the enormous amount of arrear reductions of transit observations which he accomplished, and for his well-known 1880 Cape Catalogue of Stars. In all this work Mr. Finlay took his full share.

As an observer, Mr. Finlay was very zealous in the observation of comets and occultations of stars. He independently discovered the great comet of 1882, and also one, which bears his name, in 1886, and undertook the difficult task of computing its elements as well as of many another. Perhaps in astronomical circles he will be best remembered by his excellent Star Correction Tables, which exemplify the clear grasp he had of his subject, and the orderly practical habit of his mathematical mind.

In addition to his purely astronomical work, Mr. Finlay took an active part in the geodetic work which Sir David Gill, who succeeded Mr. Stone, undertook during his famous directorate. He took the principal share in the longitude operations for connecting Aden with Cape Town, and on his voyages to and from Aden he took advantage of the short stoppages of the steamer at Delagoa Bay, Quilimane, Mozanibic, and Zanzibar to determine local time at these places with portable instruments, and to exchange time signals with Cape Town. These observations and the resulting longitudes were published in the Monthly Notices of the Royal Astronomical Society.

In 1887 Mr. Finlay undertook the discussion of the tidal records of Table Bay and Algoa Bay, and the result of his analysis, which is published in the Journal of the South African Philosophical Society, is still the

basis for all tidal predictions at those ports. In addition to these activities, he became the general secretary of the Society from 1881 to 1887, in which year he was elected president. He was also a member of the Cape Meteorological Commission.

When the staff of the Royal Observatory was reorganised in 1897, Mr. Finlay was appointed the chief assistant, but owing to ill-health he was obliged to retire on pension the following year. He spent several years in England, where he completely regained his health, and upon his return to South Africa he took up the work of teaching, a task for which he was eminently suited. When Prof. Williams, of the Rhodes University, Grahamstown, left South Africa to take part in the War, Mr. Finlay took his place as professor of mathematics and surveying, and he remained there at work after Prof. Williams had returned, to within a few days of his death.

#### LÉON MAQUENNE.

LÉON MAQUENNE, whose death is announced, was born in 1853, and will be remembered as one of those able experimenters and clear-sighted research workers who made notable discoveries in the domain of organic chemistry when the science was still in its infancy and before any really definite views as to the structure of carbon compounds, especially those of natural origin, had been developed. His most noteworthy contributions deal with the structure of the sugar alcohols, important naturally occurring substances which, for many years, resisted the attack of the chemists of his time, and his first achievement in this field was the determination of the constitution of inositol, a compound which occurs widely in both the animal and vegetable kingdoms. He was able to show that this sugar alcohol was hexahydroxycyclohexane, and thus not only established the structure of the first member of an important new series, but also indicated the close relationship which exists between substances produced in the organism and benzene.

Maquenne was also successful in determining the constitution of perseitol, a seven carbon sugar alcohol which occurs in the leaves of *Laurus Persea*, but his most outstanding work in this connexion was probably the isolation of the dextro form of erythritol by the reduction of *l*-threose, a discovery which was shortly afterwards supplemented by the preparation of *d*-erythritol by his pupil Gabriel Bertrand, who isolated it by the action of the "sorbosé bacterium" (*bacterium xylinum*) on natural erythritol. The two enantiomorphs were then united to form the *racemic* modification which was found to be identical with the compound which Griner had synthesised in 1893 from divinyl. The natural form of erythritol is the *meso* modification, but both the *meso* and *racemic* stereoisomers were prepared by Griner in his synthesis.

Of special importance also is the work carried out by Maquenne on starch, which is embodied in a series of papers published during 1904 and 1905. One outcome of this investigation was the discovery, made with Eugene Roux, that crude starch is a mixture of amylose and amylopectine.

During recent years Maquenne turned his attention more particularly to biochemical problems, and he was able to elaborate many important and delicate methods

of analysis. His great range of knowledge led him, however, to carry out researches over a wide field, and to him, amongst other things, is due the preparation of pure acetylene from barium carbide, as well as the method of eliminating nitrogen from the air by means of metallic magnesium, which was ultimately used by Rayleigh and Ramsay in the preparation of argon.

ALL who are concerned in the world of shipping and in the electrical industry will learn with regret of the death on March 17, a few hours before his forty-sixth birthday, of Mr. W. W. Bradfield, general manager of the Marconi International Marine Communication Co., Ltd. Practical radio telegraphy, particularly in connexion with shipping, owes much to Mr. Bradfield, whose connexion with the Marconi Company dates from September 3, 1897, when he entered what was then known as the Wireless Telegraph and Signal Company, Ltd. As electrical assistant to Senatore Marconi, in the earliest days of commercial wireless, Mr. Bradfield took part in experimental work on Salisbury Plain, and assisted in the erection of the wireless station at the Needles, Isle of Wight. In the year 1899 he installed the first wireless apparatus on British battleships, and a little later took charge of the demonstrations to the United States Government on board the U.S. battleship *Massachusetts*, while in 1901 he undertook similar demonstrations before the French Government, when communication was established between the French Riviera and Corsica. In the same year he supervised the erection of the famous stations at Siasconset (Nantucket Island) and the Nantucket Lightship. From 1902 until 1908 Mr. Bradfield was chief engineer to the Marconi Wireless Telegraph Company of America, and during this time he took part in the first International Radio-Telegraphic Conference, held in Berlin in 1906.

SIR WILLIAM PECK had occupied the post of City Astronomer of Edinburgh, in charge of the Calton Hill Observatory, since 1889, when the erection of the new Royal Observatory on Blackford Hill set the older building, with most of its instruments, at liberty. He was of an active and inventive mind, and interested in all mechanical pursuits, besides astronomy. He constructed many of his own instruments. He was, in addition, a popular lecturer of considerable power and attraction, and was the author of a popular "Handbook and Atlas of Astronomy" and other works. The City Observatory was devoted chiefly to showing the heavens to visitors—a service much appreciated by the citizens. For this purpose a six-inch photovisual telescope, presented to the observatory, was of good service. In pursuance of the science, Sir William Peck visited Spain for the eclipse of 1905, and Egypt in 1908. He received the honour of knighthood in 1917. He died on March 7, after a long illness, aged sixty-three years.

WE regret to announce the following deaths:

Prof. A. Dendy, F.R.S., professor of zoology in the University of London (King's College), on March 24, aged fifty-nine.

Mr. H. E. Jones, president in 1917 of the Institution of Civil Engineers, on March 24, aged eighty-two.

## Current Topics and Events.

It has been common knowledge for some time in the scientific world that the Royal Society intended to dispose of part of the collection of early printed books in its library, especial attention having been directed to the fact in the report of Council issued to fellows in November last, and published in the Year Book of the Society. While it is true that during the last few years the Society has received large gifts of money, it has to be borne in mind that without exception the application of such moneys has been limited to certain definite objects, and none is available for the general purposes of the Society, however badly it may be needed; that, no doubt, explains the last sentence of the president's letter to the *Times* of March 27, "As circumstances stand, sentiment must be tempered by practical expediency." The larger portion of the books are relics of the collection presented to the Society in 1666 by Henry Howard, afterwards Duke of Norfolk, and only those volumes which have no scientific interest or are duplicates are being offered for sale; but two of the books which are likely to fetch very high prices—a Bible, and Richard Baxter's "A Call to the Unconverted," both translated into the Massachusetts Indian language—were presented to the Society in 1669 by John Winthrop, Governor of Connecticut. One of the features of the collection is a series of several hundred Reformation Tracts printed in Germany, more than one hundred of these being by Martin Luther. Among other books of interest are Caxton's second edition of "The Canterbury Tales," 1484, Fust's "Liber Sextus Decretalium" (1465), and Cicero's "De Officiis" (1466). A first edition of Euclid, included in the sale, is a duplicate. It is the intention of the president and Council that the proceeds shall be kept as a separate fund, known as "The Arundel Library Fund," to be used for the purchase of scientific books. A nucleus has already been formed by the sale to the British Museum, at its own valuation, of some seventy items.

THE Council of the Institution of Electrical Engineers has addressed a letter to the Postmaster-General stating that some of the provisions of the Wireless Signalling Bill are of such far-reaching importance that unless they are modified they will prove a serious hindrance to electrical and physical research. In particular the Council desires that it should be made perfectly clear that the words "any apparatus for wireless telegraphy" apply only to such apparatus when used for signalling purposes. Crystal detectors and radio valves, for example, are used in many physical laboratories for testing apparatus and materials which have no connexion with radio signalling. It should be clearly stated in the Bill that licences are not required in these cases. It is also recommended that all regulations made by the Postmaster-General under Clause 3 (Regulations and Fines) of the Bill should be submitted to a statutory advisory committee for consideration, and it is suggested that the committee should be representative of the Royal

Society, the Institution of Electrical Engineers, the Radio and other interested societies. We think that this suggestion is a good one and would form an effective barrier against legislation which might injuriously affect research. It is also pointed out that Clause 7 of the Bill, which applies its provisions to the use of etheric waves for the transmission of energy, may greatly interfere with research and industrial development. A new clause might be substituted for it rendering liable to penalties any one using electromagnetic radiations of the frequencies commonly employed in radio telegraphy in such a way as to affect injuriously the working of authorised radio telegraphic stations. It is conceivable that in the future important industries may be founded on the transmission of energy by etheric radiations. Several suggestions for utilising these radiations have already been made, and it would not be in the national interest to hamper unnecessarily research in these directions.

THERE has been a considerable addition to our knowledge of scarlet fever during the last year through the researches of G. F. Dick and his wife, Gladys H. Dick, of the John McCormick Institute for Infectious Diseases in Chicago. Hitherto the causation of scarlet fever, like the other exanthemata, has been completely obscure. It was not regarded as likely that any of these fevers were due to ordinary bacteria, for although bacteria have been constantly found in one and all of them, no single bacterium isolated has been able to reproduce the disease in man or animals. The Dicks have, however, obtained (1923) a streptococcus from a case of purulent infection of the hand of a nurse suffering from scarlatina, and have directed attention to certain of its peculiarities. The application of pure cultures of this streptococcus has been alleged to produce scarlet fever in man, and it is concluded that, after all, scarlet fever is probably a bacterial disease analogous to diphtheria in its general pathogenesis. The organism is supposed to produce a local lesion in the throat, and a soluble poison produced in this site is absorbed into the system and is the cause of the rash and some other manifestations of the fever. By applying the toxin of the streptococcus scarlatinae to the skin, a very definite red area appears in some persons but not in others. Where this "Dick reaction" is positive the individual is presumed to be susceptible to scarlet fever. Where the reaction is negative the individual is immune. These reactions are strictly analogous to the Schick reactions in diphtheria. It is possible to pick out the immunes from the non-immunes, and by inoculating the latter it is hoped that scarlet fever can be completely controlled as diphtheria has been. These results of the Dicks have been confirmed in all important respects by trustworthy workers in the United States, and the subject is now receiving close attention in Great Britain.

A STEP towards the improvement of loan facilities between libraries of university rank in Great Britain has been taken by the Association of University

Teachers, which recently convened a Conference to consider the matter. As a result, regulations for inter-library loans have been approved, and inquiries are now being dealt with by Mr. Oldaker, the University, Edmund Street, Birmingham, to whom all correspondence should be addressed. The movement is a healthy one, for it represents a reaction against the policy of library inflation which was characteristic of library administration in the latter half of last century. It is now seen that the future needs of the research student can only be met by a pooling of the resources of our research institutions. We have, however, some doubt as to the wisdom of instituting at this stage the inquiry office in Birmingham. To provide prompt and accurate answers to inquiries as to the place of deposit of a given work presupposes the existence of an extensive collection of bibliographical serials and library catalogues which are to be found in few municipal or university centres. Moreover, the inquiry officer should have access to the work for the loan of which application is made. Further, the institution to which he is attached should be equipped with modern photographic copying apparatus. Few institutions comply with these requirements. The A.U.T. appears to have overlooked the fact that the bibliographical aspects of the problem should in the first instance have been left to the decision of bibliographers. We think it would be wise even at this stage for the A.U.T. to refer its proposals to a small committee of experts to consider whether the institution of a separate inquiry office is best calculated to secure the professed objects, and in case of an unfavourable answer, to authorise the committee to submit alternative proposals.

SIR OLIVER LODGE'S seventh and last "talk" of the series on "Ether and Reality," which is being broadcasted from the London station 2LO of the British Broadcasting Company, was given on March 31, and dealt with the probable utilisation of the ether. The ether or continuum has perfect properties, while matter is liable to deterioration and dissipates energy. No law of dissipation applies to the ether; matter exists not only inorganically but also as the complex molecules of protoplasm, which can be animated and made a vehicle for "life." But the coherence of all bodies is effected by the etheric connecting medium, and the question arises: Can that ether body be animated too? We usually ignore the ether body because it is outside the ken of our senses, but knowing what we know of matter and its fields of force, it is reasonable to suppose that we act more directly on ether than on the discontinuous particles of matter. All force is exerted through the ether, and it is thus that matter has become indirectly and apparently amenable to life and mind and memory and affection. These psychic attributes belong to the unseen universe, and if they require a physical medium, the ether is permanently available. Our material bodies have thus been built up, and are worked for temporary purposes of demonstration here and now, but they are imperfect and wear out. Mind may always need a vehicle, a body, a habitation,

an instrument, but it need not be made of matter. It is doubtful if matter is ever really animated directly. Our present connexion with matter is probably indirect as well as temporary. Sir Oliver stated that, in his opinion, permanent reality lies in a region which does not appeal to the senses,—a region of inference; and to that region we really belong.

SIR ERNEST RUTHERFORD, in his discourse at the Royal Institution on Friday, March 27, on atomic nuclei, stated that the most direct method for determining the nature and magnitude of the forces that hold the atom in equilibrium, and the size and constitution of the nucleus, is to examine the scattering of swift  $\alpha$  particles when they traverse matter. Such experiments have shown that the inverse square law appears to hold over the greater part of the space occupied by the atomic structure. It breaks down, however, when the  $\alpha$  particle approaches very close to a light nucleus like that of hydrogen or aluminium. By studying the variation of the number of  $\alpha$  particles of different initial velocity scattered nearly backwards from the bombarded material, it has been found that there is a sudden change in the law of scattering for aluminium for a definite velocity. Experiments made with thin films of gold and uranium show that the law of the inverse square holds to the closest distance of approach of the  $\alpha$  particle to the nucleus, namely, about  $3 \times 10^{-12}$  cm. This is remarkable, for from radioactive information it is believed that the nuclear structure of uranium extends to more than twice this distance. A distribution of charged electric doublets in the form of satellites extending some distance from the central nucleus may account for these effects. Previous work has shown that a change in nuclear structure can be brought about by intense collisions between  $\alpha$  particles and light nuclei, but the fate of the  $\alpha$  particle after liberating a proton has been a matter of great uncertainty. Some recent experiments by Blackett show that in the case of nitrogen the  $\alpha$  particle may be captured by the nucleus. Thus in the case of nitrogen there is on the whole a building up rather than a disintegration. This result is of great importance and interest, but we are still far from understanding the mechanism of such disintegrating collisions.

A SERIES of interesting demonstrations has been given at Messrs. Selfridge and Co., Ltd, London, W.1., by Mr. J. L. Baird, of an experimental apparatus of his own design for wireless "television" (*i.e.* the simultaneous reproduction at a distance of an image of a fixed or moving object). The inventor does not claim any great perfection for his results, but we have seen the production in the receiver of a recognisable, if rather blurred, image of simple forms, such as letters painted in white on a black card, held up before the transmitter. Mr. Baird has overcome many practical difficulties, but we are afraid that there are many more to be surmounted before ideal television is accomplished. In the transmitting apparatus, the object, strongly illuminated, is placed opposite a revolving disc provided with a series of lenses, each a little nearer to the centre than the last, which project a

series of moving images upon a selenium or other photo-electric cell, each a little displaced laterally from the last. This is the equivalent of passing the cell over the whole surface of the object in a succession of close parallel lines. The light thus reaching the photo-electric cell is rhythmically interrupted by a rapidly revolving slotted disc, and the result is that owing to the variations of resistance of the cell, undulations at an audio-frequency are produced in the current through it, whenever a bright part of the object is being dealt with. These are amplified and supplied to a simple wireless transmitter which is caused to emit corresponding signals..

IN the receiving section of Mr. Baird's television apparatus, the signals sent out from the transmitter are detected and amplified by very powerful valves until they are strong enough to light up a neon tube when a signal is received, *i.e.* when a bright part of the object is being dealt with by the transmitting apparatus. A disc with lenses or holes corresponding to the lenses of the transmitting disc is rotated synchronously with the transmitting disc, causing spots of light produced by the neon tube to appear upon a screen in positions corresponding to the part of the object being dealt with. With a sufficiently rapid rotation of the discs, a recognisable image of the object is produced. A duplicate of the receiving apparatus is provided at the sending end with its disc mounted on the same shaft as the transmitting disc, to enable the necessary adjustments to be made. Synchronism between the sending and receiving discs is obtained by a little alternator with a frequency of about 300 geared to the revolving system, which causes signals to be sent out by another wireless transmitter at this frequency. These are received and amplified at the receiving station to an extent enabling a similar little alternator connected to the receiving discs to be synchronised with them.

DR. A. W. CROSSLEY, presiding at the annual dinner of the Chemical Society on March 26, referred to the difficult position in which the Society finds itself on account of the increased cost of publication. Subscriptions of fellows have been raised, various limitations have been placed upon the distribution of the Society's publications, and papers are curtailed as much as possible, yet there is a financial deficit, and no practical means of avoiding it have yet been found. During the War, chemists saved the nation from disaster by supplying drugs, poison gases and protection from them, and other products demanded by the times, and it does not seem too much to ask that assistance should now be afforded in placing upon record the work they are doing for the advancement of knowledge. When one remembers the vast sums expended upon the verbatim reports of proceedings in Parliament published in the large volumes of Hansard, and considers how trivial most of the matters are in comparison with the original contributions made to a body like the Chemical Society, it is difficult to understand the national sense of value which leaves the Society in its present anxious position. Possibly the additional 1500*l.* received by the Royal Society

in aid of scientific publication will enable a grant to be made to the Chemical Society, but in our opinion a very strong case can be made out by many other scientific societies for assistance towards costs of publication, either from the State or private benefactions, and we should like to see a concerted effort made with the view of securing adequate funds for this purpose.

MR. W. J. U. WOOLCOCK referred at the annual dinner of the Chemical Society on March 26 to a scheme for the establishment in London of a "Chemistry House" which would provide office accommodation for the chief chemical societies as well as one or more lecture theatres and other facilities. The scheme is being put on a business footing, and there is every reason to believe that it will take definite shape before long. It is possible that other scientific societies may like to be housed in the same building, and the plans may be enlarged to enable this to be done if there is a clear demand for such increased accommodation.

So far most of the clinical reports on "Bayer 205," now renamed "Germanin," have encouraged the belief that at last a specific for the treatment of trypanosomiasis has been found. A paper by Dr. Clement Chesterman in the Transactions of the Royal Society of Tropical Medicine and Hygiene (1924, vol. 18, p. 311) is somewhat disturbing from that point of view. Seventeen cases, all well advanced in the "second" or nervous stage of the disease, were treated with the new drug. Of these, nine had already received arsenical drugs without permanent improvement, and eight had not been given any previous treatment. Nine of these cases relapsed in from six weeks to fifteen months after a course of "Bayer 205." Two died of acute nephritis after their discharge from hospital and two from intercurrent bilharzial dysentery. Two more, who had suffered from amblyopia during arsenical treatment, became blind after administration of "Bayer 205," and a third developed amblyopia more quickly than usual when given arsenical treatment after a course of the new drug, due, it is suggested, to the possibility that damage to the kidneys by "Bayer 205" prevented the usual rapid elimination of the arsenic afterwards given. Two cases were definitely improved and have remained so for four and five months respectively. Unfortunately, none of the cases could be re-treated owing to the small supply of the drug available. It is pointed out that the two cases who died from acute nephritis might have been saved by careful nursing but were brought back to hospital too late. Dr. Chesterman has not lost faith completely in "Bayer 205," but thinks it important that "the limitations of yet one more of tropical medicine's 'conquering heroes' should be realised."

THE genesis of "Bayer 205" is described in a recent paper (*Zeitschrift für angewandte Chemie*, 1924, vol. 37, p. 585) by Dr. B. Heymann, one of the chemists who took part in the long and arduous researches which resulted in its discovery. There

is a good deal of special pleading for the Bayer Co.'s refusal to disclose the constitution of the new drug, and this is critically commented on by M. Fourneau (who, it will be remembered, re-discovered "Bayer 205," or at least made an effective substitute for it) in *Chimie et Industrie*, 1925, vol. 13, p. 284. Whatever the ultimate value of "Bayer 205" as a remedy for sleeping sickness may prove to be, there can be no doubt that its advent has provided chemists and pharmacologists with new ideas for chemotherapeutical work.

PROF. H. A. LORENTZ, of Leyden, Holland, will deliver the fifteenth annual May lecture of the Institute of Metals on May 6. The subject of the lecture will be "The Motion of Electricity in Metals."

THE seventy-fifth anniversary of the foundation of the Royal Meteorological Society will be celebrated on April 21 and 22. The celebrations include a visit to Kew Observatory and a lecture by Prof. E. van Everdingen, director of the Royal Netherlands Meteorological Institute, and president of the International Meteorological Committee.

THE Fondation George Montefiore, given every three years for the best original work of the preceding three years on the scientific advance and on the technical applications of electricity, is to be awarded this year. The 1923 award was deferred and the prize now amounts to 22,500 francs. The committee of award consists of ten electrical engineers, five of whom are Belgian, under the chairmanship of the Director of the Montefiore Electrical Institute of Liège. Competing works, addressed to M. le Secrétaire-archiviste de la Fondation George Montefiore, Association des Ingénieurs électriciens sortis de l'Institut électrotechnique Montefiore, rue Saint-Gilles, 31, Liège, must be received by April 30 next.

THE first annual report has been issued of the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation. Thirty-two applications for grants were received from various countries and eight awards were made, involving a sum of 8550 dollars. For the present, problems in or bearing on medicine are to be favoured and preference will be given to groups of researches on a single problem. Thus last year, four of the grants were for work bearing on chronic nephritis. Two only of last year's awards, to Dr. A. Bezredka, Pasteur Institute, Paris, and to Dr. J. Aberlin, Berne, went outside the United States. Applications for grants for 1925-26 must reach Dr. F. W. Peabody, Boston City Hospital, Boston, Mass., before May 15 next.

ARRANGEMENTS are in progress for a meeting of the Commission for the Exploration of the Upper Air to be held at the Meteorological Office, South Kensington, on April 16-22, under the presidency of Sir Napier Shaw. The Commission is in connexion with the International Meteorological Committee. The principal business of the coming meeting is to discuss the publication of the results obtained by balloons and kites in the various countries of the world during the years 1923 and 1924. A sum to meet the expenses

of a specimen volume was allocated by the Union of Geodesy and Geophysics at Madrid in October last.

AMONG the financial items recently adopted by the French Chamber of Deputies is one of unusual interest to scientific workers. The clause in question is due, according to the *Revue générale des Sciences*, to Prof. Emile Borel, and provides for a tax of 5 centimes on each 100 francs paid in salaries by French commerce and industry, and the products of the tax, which it is estimated will bring in about fourteen million francs a year, is to be allocated to French scientific laboratories. In this way it would seem that industry might be made to contribute directly to the support of the fundamental scientific research on which it is based. The measure has still to be passed by the Senate before becoming law.

THE Norwich Castle Museum Committee of the City Corporation has under consideration the celebration of the centenary of the foundation of the Museum under the presidency of the famous Norwich botanist, Sir James Edward Smith, F.R.S., in 1825. The history of the Museum shows that its fortunes were of a varying character until 1894, when the Corporation took over the collections of the Museum Society and housed them in the spacious galleries adjacent to the Castle. The year 1925 is important for the City of Norwich, as in addition to the celebration of the centenary of the Museum, there will be an official opening of the Bridewell Museum of Local Industries in the 13th-century house of the first Mayor of Norwich, which will provide about 11,000 feet of floor space for the exhibition of material illustrative of the textile and other past and present industries of the City of Norwich.

IN publishing the first biological number of the Science Reports of the Tohoku Imperial University, Sendai, Japan, Prof. S. Hatai announces the formal opening of the Biological Institute of this University and of a Marine Biological Station, located at Asamushi. Among the special features of this station is an under-sea laboratory and a spacious open marine pool for observations on the growth of marine organisms. Several residences and a large dormitory have been erected where investigators may live with their families and where students may find suitable accommodation. Prof. Hatai hopes that his colleagues in Japan and in other countries may take advantage of the facilities offered for research.

YEAR-BOOK No. 23 of the Carnegie Institution of Washington, recently issued, contains a report by the Department of Genetics. The investigations reported upon range from chromosome studies in *Datura* and *Drosophila*, sex conditions in Cladocera, pigeons, and moulds, to the genetics of rabbits, mice, and horses, and eugenic studies of Indian-negro-white racial complexes in Virginia, inheritance of exceptional intelligence, the endocrines of mongoloid idiots, and a European study of the ancestry of American immigrants. No attempt can be made here even to outline the results obtained in these and other fields of research, but it is clear that substantial

progress is being made in such problems as the further analysis of the relations between chromosomes and heredity, and the compilation of data on which the improvement (germinally) of the human race could be based.

WE have received the annual report for 1924 of the Crichton Royal Institution, Dumfries—a hospital for mental diseases. Both private and rate-aided patients are admitted, numbering approximately 630 and 339 respectively during the year. Some 70 per cent. of the private admissions were voluntary, but all the rate-aided admissions were under certificate, and the medical superintendent, Dr. Easterbrook, comments forcibly on the obsolescent provisions and objectionable terminology under existing statutes which officially distinguish the latter class as "pauper lunatics," and he points out that the absence of definite statutory provision for the treatment of rate-aided patients as voluntaries has had unfortunate results. A well-equipped clinical and pathological laboratory conducts much useful work at the Institution, which has received commendation from the Commissioners of the General Board of Control after inspection.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: Grade IV. of the Civilian Educational Staff of the Royal Air

Force, preferably with engineering qualifications and experience.—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2; Bio-chemist at Dove Marine Laboratory, Cullercoats.—The Registrar, Armstrong College, Newcastle-upon-Tyne; an assistant lecturer in the department of physiology of the Welsh National School of Medicine.—The Secretary, University College, Cardiff (April 11); a lecturer in morbid anatomy and histology in the University of Manchester.—The Internal Registrar (April 15); a research fellowship at Somerville College, Oxford, open to Oxford women graduates.—Miss Lorimer, at the College (April 16); woman as principal administrative officer of King's College for Women, Household and Social Science Department, Campden Hill Road, W.8.—The Chairman of the Executive Committee (April 16); two assistant lectureships in physics in the University of Manchester.—The Internal Registrar (April 18); the professorship of bio-chemistry at Middlesex Hospital Medical School.—The Academic Registrar, University of London, South Kensington, S.W.7 (April 23); the professorship of chemistry and directorship of the department of chemistry, the University of Birmingham.—The Secretary (May 1); four scientific assistants for the science exhibition of the Royal Society at the British Empire Exhibition.—The Secretary, British Empire Exhibition Committee, Royal Society, Burlington House, W.1.

### Our Astronomical Column.

TWO NEW COMETS.—Comet 1925 *a* was discovered by Herr Schain at Sineis Observatory, Crimea, on March 23. It is of the tenth magnitude and visible in moderate telescopes. When discovered it was near  $\beta$  Virginis, and was moving slowly to the north-west. Being nearly opposite to the sun, it is observable for most of the night. The following positions have come to hand:

G.M.T. (new).	App. R.A.	App. N. Decl.	Observer.	Place.
d. h. m.	h. m. s.	h. m. s.		
Mar. 23. 22 43.6	11 47 48.9	1 43 49	Schorr	Bergedorf.
" 25. 23 42.3	11 44 8.3	1 53 46	Vinterhausen	Copenhagen.
" 27. 23 37.5	11 40 32.2	2 3 22	Steavenson	Norwood.
" 29. 0 22.0	11 38 39.7	2 7 53	"	"

The last place depends on an approximate position of the star  $BD + 2^\circ 2468$ , mag 9.5; assumed place for 1925.0,  $11^h 39^m 6.3^s$ ,  $2^\circ 12' 12''$ . Use should not be made of this position until a better star-place is available. The comet's R.A. is diminishing by about  $1^m 53^s$  daily, its declination increasing by  $5'$  daily.

The orbit has not yet been calculated, but the ascending node is evidently near  $0^\circ$ , and the inclination not large; this fact would make an elliptical orbit not unexpected.

Comet 1925 *b* was found by Mr William Reid at Cape Town on March 24. It should be stated, in correction of some paragraphs in the press, that Mr. Reid, whose diligence and success in comet-sweeping are well known, is not on the staff of the Cape Observatory, but is an amateur.

This comet is brighter than the other, being of magnitude 8, but its low altitude is a hindrance to easy observation in England. The following positions have come to hand:

G.M.T. (new).	App. R.A.	App. S. Decl.	Observer.	Place.
d. h. m.	h. m. s.	h. m. s.		
Mar. 24. 21 33.0	13 29 47	20 16 0	Reid	Cape Town.
" 28. 1 9.4	13 26 58.3	21 5 16	Steavenson	Norwood.
" 28. 2 49.0	13 26 54.5	21 6 15	"	Algiers.
" 29. 1 12.0	13 26 0.1	21 20 36	Steavenson	Norwood.
" 29. 1 29.0	13 25 59.8	21 20 54	"	"

The R.A. is diminishing by 54 sec. daily, the south declination increasing by nearly  $16'$  daily.

The orbit has not yet been calculated, but, as in the case of Comet 1925 *a*, the observations given should be sufficient to deduce preliminary orbits. Reid's comet is not far from  $\gamma$  Hydrae, and is due south about three-quarters of an hour after midnight. There will be more chance of observing the comets after the moon has set.

BROADENING STELLAR SPECTRA.—In Mon. Not. R.A.S., vol. 85, p. 47, Dr. W. J. S. Lockyer, Director of the Norman Lockyer Observatory at Sidmouth, describes a new method of broadening stellar spectra for purposes of reproduction. Since stellar images are merely points, the spectra have no breadth unless special methods are adopted to broaden them. For practical purposes it is customary to allow the image of the star to "trail" on the photographic plate by a suitable adjustment of the rate of the driving clock, but very little breadth is usually possible owing to the increased time of exposure entailed. Further, various unavoidable irregularities in brightness make the spectra broadened in this way unsuitable for picturesque reproduction. In the arrangement devised by Dr. Lockyer, the original negative, showing a narrow spectrum (after being specially prepared in a manner explained in the paper) is allowed to fall under gravity in a direction parallel to the spectrum lines, its speed being regulated by a flow of oil which, by an ingenious arrangement, is produced by the fall. During the fall the negative is illuminated by a constant source of light and photographed, the breadth of the spectrum thus obtained clearly being determined by the distance of descent. The paper contains an account of investigations made to determine the most satisfactory time of exposure, and also a beautiful photograph of the spectrum of a Cygni broadened by the new method.

## Research Items.

**THE STONE AGE IN THE EASTERN SAHARA.**—In the course of an account of the oasis of Kavar (Kaouar), Eastern Sahara, in *La Nature* for March 14, Capt. Marius Prevost, who writes in collaboration with Dr. Lucien Mayet, describes stone implements found on a considerable number of sites in the oasis explored by him. The implements occur in such numbers as to suggest that the oasis supported a considerable population from an early date. In addition to flint, which was imported, quartz, quartzites, silicious limestone, hæmatite and volcanic rocks were used in the manufacture of the implements. In the absence of stratification, the only indication of date is the somewhat uncertain evidence of type. On this basis certain implements worked sometimes on one side, sometimes on both; flakes, points, carinated implements, etc., would, if found in Europe, be classified beyond question as palæolithic, while others, arrow-heads, with or without tang, or triangular, spear-headed knives, polished axes, etc., would belong to the neolithic. Beads and pendants of stone and ostrich shell were also found. The neolithic industry shows strong affinities with that of Egypt which, if contemporary, would indicate an antiquity of 9000 to 12,000 years, and the palæolithic type might therefore be assumed to be older still. Up to the present, neolithic typology in the Sahara seems to point to a great uniformity of culture in the whole area.

**ARCHÆOLOGICAL RESEARCH IN CENTRAL AMERICA IN 1924.**—A report by Dr. Sylvanus G. Morley, in Year Book No. 23 of the Carnegie Institution of Washington, covers a number of investigations in Central America. A fourth Initial Series from the Maya New Empire region of Yucatan has been discovered. Excavations by Mr. E. H. Morris at Chichen Itza in the "Court of the Thousand Columns" have cleared the North-eastern Colonnade, an edifice 100 feet in length by 49 feet in width facing south. On three sides and part of the fourth it was bounded by solid walls, but the remainder of the support of the superstructure was a series of 5 rows of columns, rectangular in cross section. Their height was 8 feet. The season's excavations confirmed the type of the most prevalent form of column-supported structure at Chichen Itza, with a rectangular plan, arches paralleling the longer dimension, and an altar or throne at the centre in the rear. In the course of a survey of the archaeological area by Mr. Kilmartin, a number of partly finished sculptures were discovered which throw light on the technical practices of the Maya in this art. Measurements of the great terrace show that it contained an area of 47 acres and, in some places, was built up to a height of 25 feet. At Uaxactun, Guatemala, a structure was discovered which appears to have been a sun observatory. Dates on three stelæ discovered nearby equate with A.D. 97 and A.D. 235, and the observatory, therefore, if it be one, cannot have been erected later than the latter year and was planned before the two earlier stelæ were set up. Excavations by Mr. O. G. Ricketson, jun., in mounds at Baking Pot, British Honduras, have brought to light a number of skeletal remains. In a sepulchral structure were found seven skeletons. In two the upper front teeth were filed, and in one the five upper teeth were inlaid with circular fillings of iron pyrites. All showed signs of fronto-occipital flattening.

**FISH TRAPS IN EASTERN ASIA.**—The distribution of thorn-lined traps in Assam and farther east is discussed by Mr. Henry Balfour in *Man* for March.

The principal feature of these traps is that the inside of a conical trap is lined with the thorns which beset the leaf-ribs of climbing palms (*Calamus*, *Dæmonorops*, etc.), the sharp points being set toward the apex of the cone, thus rendering exit impossible when the trap has once been entered. Such traps had not been recorded from the Naga Hills of Eastern Assam prior to 1922, although their existence seemed probable from the Indonesian affinities of Naga culture. Inquiry, at first unsuccessful, finally produced an example from the Lhota Nagas from Okotso Village which is practically identical with the forms which range through the Malayan and Indonesian areas and extend as far as Melanesia. Several varieties of similar traps have since been collected from other Naga tribes by Mr. J. P. Mills. Varieties of the trap are noted from Western Burma, Malaya, Sumatra, the Philippines, Borneo, New Guinea, where it is widely distributed, New Britain, and the Solomon Islands. Though the place of origin is uncertain, there is no doubt that these thorn traps are referable to a common prototype and form a connected series.

**THE DISCOVERY OF THE ANTARCTIC CONTINENT.**—It has long been the practice to credit Sir J. C. Ross with the discovery of the Antarctic continent when he sighted South Victoria Land in 1841. Some years ago the late Dr. W. S. Bruce showed that the real discovery was made in 1820, when E. Bransfield sighted Trinity Land, a part of that section of Antarctica now known as Graham Land. In the *Geographical Journal* for March, Lieut.-Commdr. R. T. Gould publishes the full evidence on which Dr. Bruce based his contention. Bransfield's own log-book has disappeared, but contemporary accounts of his voyage are available. One of these that had previously been overlooked, together with Bransfield's own charts, which are in the possession of the Admiralty, make it clear that in January 1820 he sighted the northern extremity of the mainland in the vicinity of the mountain which now bears his name. Lieut.-Commdr. Gould's article is accompanied by a chart on which Bransfield's discoveries are shown in relation to more modern surveys, and his track is marked as accurately as is possible in the absence of the log of the *Williams*.

**USE OF STIBAMINE IN KALA AZAR.**—In the *Indian Medical Gazette* for January 25, Dr. Napier, who is in charge of kala-azar investigations at the Calcutta School of Tropical Medicine, has an interesting note on the treatment of this disease by derivatives of stibamine (*p*-aminophenylstibinic acid). It is well known that sodium antimonyl tartrate is an effective remedy, but it is slow and the coolie victims prefer as a rule to put up with the disease rather than submit to injections of this drug for several months. Improved remedies are therefore urgently required, and chemotherapeutical and clinical experiments carried on in Germany, England, and India during the last ten years have shown that stibamine is almost certainly as specific in its action in kala-azar as any drug can be. Unfortunately it is unstable and too toxic for use, and the difficulty has been to find a stable form in which to administer it. The acetyl derivative, which at first seemed promising, had to be abandoned after several accidents with it, but three other promising compounds are now under trial; urea-stibamine, which appears to be a combination of carbamide and stibamine of unknown constitution, discovered by Dr. Brahmachari of Calcutta; *metachlorostibacetin*, produced by von Heyden

of Dresden, and stibamine glucoside, first made a few months ago in the Wellcome Chemical Research Laboratories, which is the subject of the note by Dr. Napier referred to above. All three new drugs seem to be about equally valuable as curative agents, and the period of treatment by them is reduced to two or three weeks. It is too soon to say which of them will prove most effective, but their advent marks an important step in the treatment of another tropical disease.

**THE ŒSTROUS CYCLE IN CATTLE.**—H. S. Murphey has published a paper on the Œstrous cycle in the cow, in the *Journal of the American Veterinary Medical Association* (vol. 65, August 1924), and G. W. McNutt in the same number has given an account of the corpus luteum in the cow in relation to the cycle. The cycle is divided by the former author into two main periods, diŒstrum and Œstrum, and the latter is subdivided into proŒstrum, Œstrum in the restricted sense (*i.e.* the actual time when coitus may occur), and postŒstrum. Both the vagina and the uterus are shown to undergo marked cyclical changes, pronounced congestion and œdema beginning with the proŒstrum and not subsiding until four or five days later. In the case of the vagina the congestion and œdema are followed by active secretion. McNutt describes ovulation as occurring shortly after "heat," an observation which agrees with what has been found by John Hammond, whose investigations at Cambridge have covered much the same ground, but have not so far been published. The corpus luteum is said to be formed both from the follicular epithelium and from the theca interna. It may commence involutionary changes after 14 to 16 days, but there is some individual variation. In young animals the involution is completed in a year or somewhat less, but as the cow grows older, involution takes place more slowly and is less complete. The colour of the corpus luteum is at first a light brown, about the 7th day an old gold, by the 14th day a bright golden yellow, and by the 20th an orange colour, eventually changing to a bright brick red. The colour change is associated with the quantity and character of the lipid in the luteal cells.

**FRUIT TEMPERATURES IN CALIFORNIA.**—A discussion of considerable value to fruit-growers is given in the recently issued *Monthly Weather Review* for August 1924 in an article on "Substitution of fruit temperatures for air temperatures in regulating orchard-heating for oranges." The essential features of the discussion aim at improvement in eliciting a more precise estimate of the lowest temperature to which fruit can be subjected without damage. For thirty years or more, orchard-heating has been practised in the United States, mostly without exact data as to effective damage, and based on the reading of sheltered and unsheltered thermometers in varying degrees of proximity to the fruit. The frosts are found not only to render the fruit unmarketable, but also in many cases to prevent the crop being included in the "choice" or "extra choice" grades. Information is given to show how successfully under ordinary cold the fruit escapes damage. A special mercurial thermometer is used; the bulb of the instrument is inserted well into the fruit, and readings from this are used for determining when the heaters should be lighted; the thermometer is somewhat similar to a clinical thermometer. It is asserted that from 85 to 90 per cent. of the fruit is screened from the sky by foliage. The freezing-point of the juices of the fruit varied from 26° to 28.5° F., and examples are given of the temperature falling to about 24° F. before the juice began to freeze. The amount of damage to

mature fruit depends largely on the thickness of the rind.

**LEECHES FROM KASHMIR.**—Dr. J. Percy Moore describes (*Proc. Acad. Natural Sci., Philadelphia*, vol. 76, pp. 343-388, 1924) the first collection of leeches from Kashmir, and it is interesting to note that the following species are included—*Glossiphonia complanata*, *G. weberi*, *Hemiclepsis marginata* (subsp. *asiatica* nov.), *Erpobdella octoculata*, and *Dina weberi*. The first, third, and fourth of these are widely distributed and abundant Eurasiatic species, the first being even holarctic. The remaining two are characteristic Indo-Malayan forms. Dr. Moore also gives an account of a collection of leeches from eastern China.

**CRITICAL STUDY OF LEIDY'S ACANTHOCEPHALA.**—Dr. H. J. Van Cleave has investigated the specimens of Acanthocephala in the Leidy collection deposited in the University of Pennsylvania and in the Academy of Natural Sciences, Philadelphia, and gives a critical review of this important material (*Proc. Acad. Natural Sci., Philadelphia*, vol. 76, pp. 279-334, 1924). He states that of the North American genera of Acanthocephala known at the present time fully half had come to the attention of Leidy. The author gives in tabular form a list of the specific names used by Leidy and the valid or corrected names, pointing out at the same time that Leidy's work was characterised by great care and that some of his difficulties in identification were due to the incomplete description of European species. Twenty-one species are represented in the collection and they are arranged under thirteen genera.

**EXPERIMENTAL STUDIES ON *DIBOTHROCEPHALUS LATUS* IN MAN.**—G. Z. L. le Bas (*Journ. Helminthology*, vol. 2, No. 4, 1924) publishes observations on three persons who infected themselves with this tapeworm by swallowing the plerocercoid stage obtained from pike taken from the Lake of Neuchâtel. Case A was infected with three worms which attained maturity (as evidenced by finding the eggs in the fæces) in 20 days; case B was also infected with three worms which reached maturity in 14 days, while the single worm in case C took 26 days to reach sexual maturity. The average length of the three worms from case B after 99 days was 22 feet, and the number of eggs present about this time per gram of dried fæces was about 7 millions in case A, and in case B 12½ millions about the 90th day of infection and 17½ millions on the 99th day. Intestinal disturbance is associated with the period of maturation of the worm, but, apart from this diarrhœa in the early stages, infection with three *Dibothrocephalus* for so long as nine months does not necessarily give rise to any symptoms which would suggest the presence of the parasite. No appreciable anæmia was produced, nor was there a definite diminution of the red blood corpuscles. Leucocytosis and an increase of the polymorphonuclear cells was observable in a slight degree, especially early in the infection.

**CLASSIFICATION OF IGNEOUS ROCKS.**—E. T. Hodge proposes a new form of classification for igneous rocks in a Publication (vol. 2, No. 7, 1924) of the University of Oregon. The older classifications are ably summarised and criticised. Single plane arrangements have hitherto been far from satisfactory. Winchell employed three planes exhibiting relative degrees of "alkalinity"; Holmes used five planes, dividing rocks according to Shand's saturation principle; and Johannsen used a solid double tetrahedron, thus introducing obvious difficulties in presentation. It is claimed that the new method

avoids the defects of previous attempts. The first division is into four *classes* based on the percentage of felspars plus feldspathoids. Each of these is divided into seven *ranges* according to the principle of saturation. Further subdivision is into nineteen *orders* depending on the ratio of orthoclase to the various types of plagioclase. The division thus makes provision for a large number of different types of rocks, all of which can be represented quantitatively in a plane circle on a single sheet. Four segments of the circle take the classes. Six smaller concentric circles give seven spaces for the ranges, and each segment is divided into nineteen smaller segments by radial lines to take the orders. So far only mineral composition has been considered, though the author makes the remarkable claim that, whether chemical or mineral composition be given, the rock will fall into the same division of the classification. Texture next requires attention, and to meet the formidable difficulties inherent in any cross classification of so variable a factor, it is suggested as a simple expedient that to each a symbol be given which could be added to the rock name as a subscript. As a mental prop a classification of this kind may have its use, but petrology has now passed the stage in which it would have been considered as a contribution to the development of the subject.

UNITED STATES COASTAL SURVEYS.—The Report of the United States Coast and Geodetic Survey for the year 1923-24, published by the Department of Commerce, Washington, contains a long record of useful work and a review of the present state of the various hydrographic, geodetic, and magnetic surveys now in hand. Among the surveys of the year the progress in Alaska was very notable. So far the work has been mainly in the waters of southern Alaska, but it is spreading northwards to the shores of Bering Strait. A new survey of the waters of the Philippines is nearly complete, and a survey of the Virgin Island waters is half finished. The provision of several new survey vessels has greatly facilitated the work of the department. The results of experiments with the sonic depth-finder on the *Guide* are promised in a separate report. The apparatus is to be used in extending the survey of Pacific coastal waters to the 1000-fathom line. The Report is furnished with numerous maps showing the present state of surveys.

FLOTATION METHOD OF CLEANING COAL.—In the Bulletin de la Société d'Encouragement pour l'Industrie Nationale of January recently received, Charles Berthelot describes fully the process of cleaning fine coal by the flotation method, and points out the advantages to be derived therefrom. He gives an account of the plant employed at the Fiscal Mines of the Netherlands, devised by the chief engineer, Mr. Kleinbentink, which differs from the well-known plant of the Minerals Separation Company in that the frothing chamber is circular in plan surrounded by a circular chamber for collecting the froth. In Holland it has given very satisfactory results, and the working costs are only half of those incurred by the Minerals Separation Company, namely 1.32 francs as against 2.66 francs per ton. The mines in question are dealing with 100,000 tons per annum of coal slimes, the ash content of which is reduced from 30 per cent. to 8 per cent., the floated coal being well adapted to the preparation of either metallurgical or foundry coke or briquettes. It is stated that the cost of a plant to treat 50,000 tons of coal slimes per annum amounts to 200,000 francs and can make a gross profit of 850,000 francs per annum. The article makes no reference to the means employed for removing the water from the froth in the Dutch plant described.

DIAMOND HARDNESS TESTING MACHINE.—In the Brinell hardness test, the steel balls hitherto used for making measurable impressions under load were themselves deformed when indenting very hard specimens. The results fell off in accuracy at an early stage. Messrs. Vickers, Ltd., have now produced a machine, employing a small diamond pyramid (included angle  $136^\circ$ ) as indenter, which gives trustworthy readings upon the very hardest steels. The use of a pyramid is scientifically sound, and the "hardness numbers" are similar to, if not identical with, those of the universally adopted Brinell scale. The indentations are very small, and the machine meets almost all the demands of a modern metallurgical hardness tester, for (a) the load is applied at a constant rate and for a constant time; (b) the load may be varied from 10 to 100 kgm. to suit the sample being tested; (c) thin sections, e.g. hardened safety razor blades, may be tested; and (d) there is no damage to finished work. The machine is suitable for research and general use, as loading is automatic and the measuring operations are simplified. A microscope is swung into position directly over the specimen, and knife edges in the eyepiece are brought up to opposite corners of the indentation. The reading then appears externally in actual figures.

SOLUBILITY AT HIGH PRESSURES.—A method of determining solubility at high pressures, by means of measurements of electrical conductivity, is described by Messrs. E. Cohen and J. C. van der Bosch in the *Zeitschrift für physikalische Chemie* of January 20. Thallous sulphate was employed, as the alteration of volume on solution is large, and a considerable alteration of solubility with pressure was to be expected. Measurements were made at various concentrations to find the relation between concentration and resistance at high pressures. To determine the maximum solubility, at 1500 atmos. for example, weighed quantities of thallous sulphate and water were taken, which would give a slightly oversaturated solution at  $30^\circ\text{C}$ .; this was placed in a suitable resistance vessel in a compression bomb, which could be constantly shaken by means of a mechanical arrangement driven by an electric motor. The pressure was raised to 1800 atmos., and the salt dissolved completely; when the pressure was reduced to 1500 atmos., without shaking, a supersaturated solution was obtained the resistance of which was determined. After long shaking the excess of salt gradually crystallised out, the resistance rising and finally becoming constant. From these measurements it was possible to find the amount of salt in the saturated solution. The method takes a long time, but the results obtained agree well with those arrived at by other observers, using the direct method.

ZINC OXIDE INDUSTRY.—An account of the zinc oxide industry by Dr. N. F. Budgen appears in the *Chemical Trade Journal* for February 20. Zinc oxide has been known from the times of antiquity; the ancients called it *tutia*, and the alchemists referred to it as *nix alba*, "philosophical wool," or flowers of zinc. Courtois recommended its use as a paint in 1770, and in 1781 he commenced the large-scale manufacture of the substance. The Wetherill process in the United States involves the reduction and distillation of zinc from oxidised ores mixed with a certain amount of anthracite to act as reducing agent. The vaporised zinc is quickly oxidised, and with the gases of combustion is drawn from the furnaces and cooled in a system of flues and chambers, finally passing into a series of muslin bags which act as filters, allowing the gases of combustion to escape, at the same time retaining the condensed zinc oxide. The difficulties and drawbacks in the Wetherill process are discussed.

## The Molecular Mechanism of Capillary Phenomena.<sup>1</sup>

By N. K. ADAM.

AN important question for the theory of capillarity is this: Is it necessary, in order to explain the observed phenomena, to conclude that there is, in the surface of a liquid, any differentiation of the molecular arrangements and forces from those prevailing in the interior, of such a nature that there is a skin possessing a tension parallel to the surface? Many writers appear to assume that, because the free energy associated with each unit of area of the surface is most conveniently replaced in calculations by a tension parallel to the surface, there must be some special structure in the surface which produces this tension physically. Although any free energy resident at the surface may mathematically be considered as the product of a "surface tension" and the area, there is no justification in this fact for concluding that the molecular arrangements and forces at the surface resemble those in a stretched membrane. Indeed, probably all attempts made to explain the molecular structure of surfaces, which have assumed such a contractile mechanism, have been complete failures.

Recent work on films of fatty material, one molecule thick, on water surfaces, has been satisfactorily interpreted in terms of molecular structure by regarding the molecules of the film simply as small floating objects, which attract one another when close enough, and repel when quite closely packed; thus assuming only the ordinary properties of molecules. If a film of this nature is confined by barriers to a given region of the surface, the force on the barriers is regarded as a compression on the floating film. Very striking analogies between the structure of the films, and the structure of matter in three dimensions and in solid, liquid, and gaseous states, have been revealed on this assumption; while if the force on the barriers had been treated as the difference between two tensions, those of the clean and contaminated water surfaces, no progress could have been made in unravelling the molecular structure. The two ways of regarding the films are mutually exclusive, and the success of the "compression theory" casts much doubt on the reality of any structure in the surface which produces tension.

A liquid probably has a well-defined surface; a surface of water forms a satisfactory support for films one molecule thick, which are as closely packed as matter in solid or liquid form, and will withstand lateral compression of one or two hundred atmospheres, calculated on their thickness. Only a liquid of density practically the same at the surface as in the interior could form a stable support for such films. The rarefied transition layers between liquid and gas, discussed by Van der Waals, can scarcely be conceived as able to bear these condensed films.

The surface energy of all liquids, and the tendency to diminish the surface to a minimum, are due in the following way to the molecular cohesion. In the interior, a molecule is attracted equally in all directions by its neighbours; at the surface the attraction outwards is lacking, and every surface molecule is therefore attracted inwards. Simple cohesive forces will produce no other net force on the surface molecules. This is sufficient to cause molecules to leave the surface more frequently than they reach it, and consequently, since the molecules occupy a definite area in the surface, the surface diminishes. The free energy of the surface is the work which must be done

to bring the number of molecules requisite to form unit area, to the surface, against this inward force.

There are two other arguments sometimes cited as evidence of the existence of a surface skin; the floating of a heavy solid object on the surface of a liquid, and the spreading of one liquid on another. But consideration of possible molecular structures for the skins which would cause a liquid surface to diminish, and would resist perforation by a solid body, show that opposite qualities would be required in the two cases. The skin tending to contract the surface would essentially expel molecules from itself; but the skin which would act as a support for a heavy body would need such cohesion that it would be most unlikely, left to itself, to diminish indefinitely.

An experiment of Osborne Reynolds<sup>2</sup> renders it very probable that spreading of oil on water is due to an outward thrust from the oil drop, instead of a pull from the water surface. Oil placed on a dusted surface of clean water pushes the dust back as it advances, only immediately at the edge of the advancing oil, there being obviously no contractile motion over the rest of the water surface. A force which can produce this expansion in the form of a thrust from the drop is not far to seek. The molecules of the water are in constant thermal agitation, and the horizontal components of this motion act in the required direction, and will carry out the molecules of oil along the surface, if they are sufficiently adherent to the water molecules to share in their motion, and are not more attracted by the oil than by the water. Evidence of the importance of these thermal motions parallel to the surface is also given by the behaviour of the monomolecular films, as the temperature rises. It is found that, when the temperature is high enough, the disruptive effect of the agitation overcomes the lateral attraction between the film molecules and causes expansion to take place, the expanded film being analogous to a two-dimensional gas.

These thermal agitations also account for the diminution of the free surface energy, or "surface tension," of all liquids with temperature. If the surface is warmer on one side of a floating object than on the other, the intensity of the horizontal bombardment on this object is greater on the warm side than on the cold. We need not regard the observed motion towards the cold side as due to the attraction of the surface skin being less on the warm than on the cold side. By reason of this difference in intensity of bombardment, work must be done to increase the area of the cold surface at the expense of that of the warm, and the "surface tension" of the cold surface is greater than that of the warm.

It is well known that the pressure is greater on the concave side of a curved liquid surface than on the convex, and that the amount of this excess pressure is  $\eta \left( \frac{1}{R_1} + \frac{1}{R_2} \right)$  where  $\eta$  is the "surface tension" and  $R_1$  and  $R_2$  the principal radii of curvature of the surface. The amount of this excess pressure can be deduced simply from the fact of a free energy  $\eta$  per unit area of the surface, by considering a variation of the area of surface, keeping the volume constant. The fact that its magnitude is the same as if the surface were covered by a membrane of tension  $\eta$  is not evidence as to the molecular mechanism by which the pressure is produced.

At the free surface, the attractions perpendicularly

<sup>1</sup> Based on a lecture delivered to the Physical Society of Sheffield, on October 28, 1924.

<sup>2</sup> Works, vol. 1, p. 410. Brit. Ass. Rep., 1881.

inwards on the surface molecules produce a pressure on the underlying molecules, the "internal pressure." Fig. 1 will show that on a plane surface the forces producing this pressure are parallel; on the surface convex outwards they are convergent and therefore the pressure is greater; on the surface concave outwards they are divergent, giving a smaller pressure than under the plane surface. Thus the unbalanced perpendicular attraction on the surface accounts for

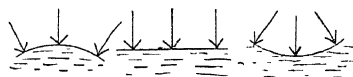


FIG. 1.

the pressure under a curved surface, without the assumption of an elastic skin.

Where the surface is the surface of separation between two liquids, or between a solid and a liquid, the attractions on the surface molecules of each phase towards the interior of that phase are modified and usually less than at a free surface; but the only net force on the surface molecules is an attraction away from the boundary. The equilibrium between the forces of attraction at the interfaces of solid, liquid, and gas, in contact, results in the angle of contact (Fig. 2). If  $W$  be the work per unit area required to

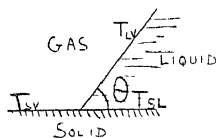


FIG. 2.

separate the solid from the liquid perpendicularly, then

$$W = T_{sv} + T_{lv} - T_{sl} \quad (1)^*$$

$W$  may be called the adhesion of the liquid for the solid. Further, the equation

$$T_{sv} = T_{sl} + T_{lv} \cos \theta \quad (2)$$

may be obtained by taking account of the changes of area involved in a virtual displacement of the line of contact of solid, liquid, and gas. Hence

$$W = T_{lv} (1 + \cos \theta) \quad (3).$$

By (3), a zero angle of contact indicates that the adhesion of the liquid for the solid is equal to the cohesion ( $2T_{lv}$ ) of the liquid for itself;  $90^\circ$  shows the adhesion to be half the liquid cohesion, and  $180^\circ$  would indicate no adhesion.

When there is motion of the liquid over the solid surface, the angle of contact is different. If the liquid is advancing, the angle is greater, if receding, it is less, than the equilibrium value. The amount of this difference, sometimes called the hysteresis of the angle of contact, probably depends more on the smoothness of the surface than on its chemical characteristics. For a rough surface of paraffin wax, for which the equilibrium angle is  $104^\circ 30'$ , the difference between advancing and receding angles may amount to nearly  $60^\circ$ ; and on such a surface it is practically impossible to obtain the equilibrium angle, within several degrees. However, on a wax surface which had been turned in a lathe, Ablett<sup>4</sup> obtained consistent results, within a few minutes of arc, for the equilibrium angle. Mr. G. Jessop has pointed out that this "hysteresis" is probably due to the friction

of the liquid on the solid surface, acting to oppose the motion. If the frictional force is  $F$ , then for advancing motion, equation (2) becomes

$$T_{sv} - T_{sl} = T_{lv} \cos \theta_A + F,$$

and for receding motion,

$$T_{sv} - T_{sl} = T_{lv} \cos \theta_R - F;$$

hence the angle must be greater for advancing than for receding motion. Also,

$$2(T_{sv} - T_{sl}) = 2T_{lv} \cos \theta = T_{lv} (\cos \theta_A + \cos \theta_R);$$

therefore

$$2 \cos \theta = \cos \theta_A + \cos \theta_R,$$

an equation approximately verified by Ablett, for his surface of paraffin wax.

This surface friction probably explains the third of the phenomena sometimes attributed to the surface skin; the floating of a solid object on a liquid of less density. In Fig. 3, the line of contact between the liquid and solid surfaces will not move unless the part of the weight of the solid not supported by the

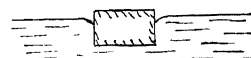


FIG. 3.

buoyancy of the liquid exceeds the frictional force  $F$ . In this way a substance heavier than water can float on the surface, as any depression of the line of contact below the level of the surface requires an increase in area of the liquid surface, if the angle of contact is greater than  $90^\circ$ , and requires the performance of work.

The sequence of events in the rise of a liquid in a capillary tube suddenly brought into the liquid will be, first, the setting up of an angle of contact (acute for a rising liquid); second, a diminution of pressure under those regions of the surface where there is disturbance due to the angle of contact, third, motion of the liquid upwards, by reason of this diminution of pressure, first probably to complete the meniscus, and then as a whole up the tube. If the tube is dry, the liquid is advancing and the angle of contact will be greater than the equilibrium angle, the radius of curvature of the meniscus will be greater, the pressure deficiency under the curved surface will be less, than the equilibrium, and the liquid will not reach the equilibrium height in the tube; this is a well-known experimental fact. Washburn<sup>5</sup> has shown that the rate of movement of liquid in a capillary tube is in accordance with the value of the capillary pressure, and the viscous resistance to flow; but this does not serve to distinguish between this explanation and one based on the idea of "surface tension," since the capillary pressure is numerically equal to what would be caused by a membrane in tension. Rideal<sup>6</sup> obtains the same differential equation for the motion of the liquid, considering the force driving the liquid as a tension of magnitude  $2\pi r\eta$ , where  $r$  is the radius of the tube, and the liquid wets the walls perfectly.

In general, where the phenomena considered are merely consequences of the fact of potential energy in the surface, the term "surface tension" can legitimately be employed; but where the molecular mechanisms producing the phenomena are under consideration, the term is apt to be misleading, as it suggests some kind of contractile skin in the surface, the existence of which is very unlikely.

\* Dupré's well-known equation. Equation 3 has been obtained by Edser, and a similar equation is obtainable from Laplace's theory, considering the attractions between particles of liquid and solid, and liquid and liquid.

<sup>4</sup> Phil. Mag. 46, p. 244 (1923).

<sup>5</sup> Phys. Review, 13, p. 273 (1921).

<sup>6</sup> Phil. Mag. 44, p. 1152 (1922).

### The Syrian Arc.

THE Syrian Arc is the name proposed by Dr. E. Krenkel for a mountain chain which can be traced around the south and east of the Levant from Tunis to the Taurus. The name is given in a short but important paper ("Der Syrische Bogen," *Centralblatt für Mineralogie*, 1924, No. 9, pp. 274-281, and No. 10, pp. 301-313) which correlates the mountain movements which have determined the position of the south-eastern Mediterranean. According to Dr. Krenkel, this mountain chain begins to the west in Tunisia, where there are two sets of fold mountains. The predominant set belong to the Atlas System and its members trend to the north-east. The set in southern Tunis trends east and west and is obviously a distinct mountain group from the Atlas.

According to Dr. Krenkel, this southern set is the westernmost element of the Syrian Arc. It is cut off by the Great Syrtis from Cyrenaica. Dr. Krenkel, from the writer's work on the geology of Cyrenaica, interprets its plateau as one of the inner members of the Syrian Arc. In Egypt this arc is represented by three fold ranges, those of Abu Roasch, Wadi Araba and Quena. It continues with a trend to the east-north-east, across the deserts of northern Sinai, where it has been determined by Messrs. Moon and Sadek. The Egyptian and Sinaitic members of the Syrian Arc are separated by the Gulf of Suez.

According to one view, the Clysman valley of Dr. Hume, which includes that gulf, is the direct continuation of the Rift Valley of the Red Sea. According to another view, it is a synclinal. According to Dr. Hume, it is due to a combination of faulting and a series of Erythrean folds. Dr. Krenkel supports the first of these interpretations as the Gulf of Suez lies in a rift valley which has broken across the Syrian Arc nearly at right angles; and the structures which have been interpreted as due to a series of Erythrean folds Dr. Krenkel explains as due "to the tossing and tilting of uniclinal sedimentary blocks which appear on the floor of the rift valley." He denies the existence of Erythrean folds due to pressure in a westerly or easterly direction.

From Sinai the Syrian Arc passes north; it is

bounded westward by a series of steps down to the Mediterranean and eastward, according to some accounts, by flexures. Dr. Krenkel regards these flexures as fractures which have broken across pre-existing folds. He attributes the topography of this area to a combination of an older folding with the younger rift valley fractures. In Syria, however, where the structure has been represented by Diener and most of his successors as determined by simple block structures, Dr. Krenkel insists on the importance of folds. In middle Syria, the Lebanon on the west is separated by the great valley of the Bakaa from Mt. Hermon and the Anti-lebanon. This valley he attributes to a down-fold lasting from the end of the Cretaceous to the Upper Miocene; but the Bakaa in its present form he describes as a rift valley made by Pliocene fractures. The Damascus Arc is a branch from the Syrian Arc and is marked by the presence of the only overfolding recognised by Dr. Krenkel anywhere along the Syrian Arc; it happened there as a result of extent owing to the pressure of the Damascus Arc against the northern edge of the Arabian Foreland. Farther north the Syrian Arc ends against the cross folds of the Taurus. The line of separation is defined by Dr. Krenkel as the Afrin line which divides the African element from those of Asia Minor.

The Syrian Arc was upraised by folding in three stages: the first movement was in the uppermost Cretaceous (Upper Danian); the second in the Lower Miocene; the third and most important was in the Upper Miocene. The crumbling was due, according to Dr. Krenkel, to pressure from the south and east toward the Mediterranean. It was therefore in the opposite direction to that in the Dinaric-Taurus Arcs, which extend along the eastern side of the Adriatic, through Greece and the Archipelago to the southern chains of Asia Minor. The general course of the Syrian Arc conforms closely to that of the Dinaric and Taurus Mountains; and both of the mountain arcs moved toward the great depression of the Eastern Mediterranean which lies between them.

J. W. GREGORY.

### Permanent Magnets.

MR. S. EVERSLED read an important and valuable paper on permanent magnets to the Institution of Electrical Engineers on March 19. The paper gives the results of many years' research, and ought to prove of immediate value in improving the quality and cheapening the cost of high-grade permanent magnets. In 1616 Barlowe wrote concerning the medieval art and mystery of magnet making—"The compass needle, being the most admirable and useful instrument in the whole world, is so hungrily and absurdly contrived as no other." Although the permanent magnet has become an indispensable adjunct of modern engineering, yet industries rooted in tradition are generally backward, and magnet making is no exception.

The hardening of iron and the making of steel were probably discovered accidentally. Metallurgists have found that ordinary pure iron exists in various allotropic forms depending on the temperature. At ordinary temperature it is called Alpha iron and is the commonest of all metals. Its specific heat at 0° C. is 0.1055 precisely, which is in excellent accord with theory. This specific heat gradually increases until about 750° C. The author calls this the precursor effect, as it indicates that the heat is not all expended in raising the temperature; some of it is

doubtless expended in effecting a change of some kind in the structure of the iron. At about 770° C. Alpha iron begins to change into Beta iron, and the transformation is practically complete at 810° C.

Alpha iron is magnetic, Beta iron is entirely non-magnetic. As the molecule of Beta iron must be quite different from that of Alpha iron it is practically a new element. Throughout the narrow zone of temperature of 40° C. Alpha and Beta molecules can exist together, and this explains the loss and recovery of magnetism in iron as shown by experimental curves. At between 918° and 920° C. Beta iron is converted into Gamma iron, and at between 1404° and 1405° C. Gamma iron becomes Delta iron, its specific heat suddenly increasing by 50 per cent. At 1528° C. pure iron melts. Assuming that specific heat is inversely proportional to atomic weight, it would follow that these varieties of iron should have atomic weights of about 56, 37, 41, and 27, which are the atomic weights of iron, chlorine, calcium, and aluminium. The molecules have not changed successively into the molecules of these elements, but they must have done something equally revolutionary.

The carbides used in manufacturing magnet steels dissolve freely in Delta, Gamma, and Beta iron, but

these kinds of iron are all non-magnetic. To make a magnet the steel must be magnetic, and consequently in the Alpha state. It is necessary, therefore, to heat the iron until it is in the Beta or Gamma state, dissolve a quantity of carbide in it, and then by plunging it into cold water make it return quickly to the Alpha state.

Nowadays carbon steel is seldom used for permanent magnets. Tungsten magnet steel is made similarly to carbon magnet steel, but half the carbide of iron is replaced by carbide of tungsten, the total content of carbon remaining unchanged. The effect of replacing part of one solute substance by another is to increase the magnetic coercive force from rather less than 50 to slightly more than 70. When cobalt is used instead of tungsten the coercive force is increased to 180. From the point of view of the manufacturer, tungsten steel is generally the most attractive. Carbon steel is 60 per cent. more costly, and cobalt steel costs three or four times as much. Cobalt steel withstands demagnetising forces much more effectively than tungsten steel. If two permanent straight magnets, one of tungsten steel and the other of cobalt steel, were subjected to demagnetising forces equal to 20 per cent. of their coercive force, the tungsten magnet would lose 14 per cent. of its strength, but the cobalt magnet would only lose 3 per cent.

The author has made many experiments on the loss of the coercive force in all kinds of "permanent" magnets. In a cobalt magnet, for example, the initial coercive force was 180, but after 4.4 years it had fallen to 161.8. The continued falling off in the coercive force of hardened magnet steel is attributed to the passage of carbide molecules out of solution. Immediately after the hardening, the coercive force decreases by about 7 per cent. in the course of the first hundred hours, but after a year the rate of decay seems to settle down to a small steady value. The author calculates that the whole of the surplus carbide in cobalt steel might pass out of solution in about seventy years, the steel then being completely softened. He has noticed, however, a seasonal oscillation in the value of the coercive force, the reason of which is still unexplained.

When manufacturing steel containing tungsten or cobalt for use in making permanent magnets, the greatest attention has to be paid to the heat treatment. The experiments described prove conclusively that if tungsten steel be heated to any temperature between 750° C. and 1214° C., and kept at this temperature for an appreciable time before hardening, its magnetic properties are weakened, the weakening increasing with the length of time the steel is kept at the high temperature. The deterioration of the steel goes on most rapidly when the temperature is 950° C. At 1200° C. the spoiling of the steel goes on very slowly, the coercive force falling only 0.4 units per hour. At 1240° C., however, which is only 26° above the danger zone, restoration of coercive force takes place at the rate of 15 units a minute. It is obvious, therefore, that great attention has to be paid to the temperature to which the steel is heated, before hardening.

This paper is a sequel to one the author read to the Institution in 1920, and together they give a very complete account of the modern theory and practice of magnet making. The results obtained by the British Scientific Instrument Research Association on the possibility of making magnets of complicated shapes by casting them with molten metal and then subjecting them to a suitable heat treatment are described. The method appears to be very promising and already cast magnets are on the market.

## University and Educational Intelligence.

CAMBRIDGE.—Particulars are now available of the Pinsent-Darwin Studentship in mental pathology, founded in 1924 by Mrs. Pinsent and Sir Horace and Lady Darwin for promoting research into any problem which may have a bearing on mental defects, diseases or disorders. The Studentship is of the annual value of about 200*l.* and is tenable for three years in the first instance. Candidates may be of either sex, and need not be members of the University of Cambridge. Applications must be sent before May 1 to the Secretary, Pinsent-Darwin Studentship, Psychological Laboratory, Cambridge.

EDINBURGH.—The following are among the honorary degrees to be conferred in July:—LL.D.: Brigadier-General the Hon. Charles Granville Bruce, chief of the Mount Everest Expedition; Prof. A. S. Eddington, Plumian professor of astronomy and experimental philosophy in the University of Cambridge; Prof. Robert Muir, professor of pathology in the University of Glasgow; Principal C. G. Robertson, University of Birmingham; Sir Harold J. Stiles, emeritus professor (clinical surgery) in the University of Edinburgh.

LEEDS.—Mr. J. Gordon has been appointed lecturer in bacteriology in succession to Dr. Ross resigned. An honorary demonstratorship has been instituted in the Department of Zoology, and Mrs. H. W. Swift appointed thereto.

LONDON.—In commemoration of the donation of 105,000*l.* made in 1914 by Sir Hildred Carlile, Bart., to the Endowment Fund of Bedford College, it has been resolved that the University chairs of English literature, Latin, botany, and physics tenable at the College shall henceforth be entitled the "Hildred Carlile" chairs.

The following doctorates have been awarded: *Ph.D. (Science)*, Mr. K. C. D. Hickman (Imperial College—Royal College of Science) for a thesis entitled "Studies in Adsorption, with special reference to the Washing of Photographic Products," and other papers, and Mr. D. F. Stedman (University College) for a thesis entitled "The Liquid-vapour Equilibrium of the System Glycerine-water"; *D.Sc. (Physics)*, Mr. F. Simeon (University College) for a thesis entitled "1. The Carbon Arc Spectrum in the Extreme Ultra-violet: 2. Note on the Striking Potential necessary to produce a Persistent Arc in Vacuum," and other papers, and Mr. B. W. Clack (Birkbeck College) for a thesis entitled "On the Study of Diffusion in Liquids by an Optical Method."

ST. ANDREWS.—The Senatus Academicus has resolved to confer the honorary degree of LL.D. on the following, among others: Sir William Bragg, Fullerian professor of chemistry at the Royal Institution, and Director of the Davy-Faraday Research Laboratory; Prof. F. G. Donnan, professor of inorganic and physical chemistry in the University of London; Prof. Etienne Gilson, professor of philosophy of the Middle Ages, Sorbonne, University of Paris; Mr. R. W. T. Gunther, fellow of Magdalen College, Oxford.

A COMPETITIVE examination for two scholarships at the Household and Social Science department of King's College for Women, namely, the Carl Meyer, 80*l.* a year for three years, and the Minor College, 40*l.* a year for three years, will be held on May 21. The latest date for the receipt of entry applications is May 18. They should be sent to the Secretary of the department, Campden Hill Road, W.8.

THE next election to the research scholarships of the Grocers' Company for the prosecution of original research in sanitary science will take place in May, and applications for them are invited until April 14. The scholarships are each of the annual value of 300*l.*, plus an allowance for apparatus and other expenses. They are tenable for a year, with the possibility of renewal for a second or a third year. Applications, upon a form to be provided, should be sent to the Clerk of the Company, Grocers' Hall, E.C.2.

THE second session of the summer school for post-graduate mathematics, organised by the Extra Mural Department of the University of Manchester, will be held at University College, Bangor, on August 24-September 5. The object of the school, which is recognised by the Board of Education, is to afford facilities for advanced study in mathematics to teachers and others who have read mathematics for a university degree. The following three alternative courses are proposed: (a) Atomic structure and the quantum theory, by Prof. Sydney Chapman (Imperial College of Science, London); (b) theory of functions, by Prof. L. J. Mordell (University of Manchester); (c) higher geometry, by Mr. H. W. Richmond (King's College, Cambridge). Particulars may be obtained from Miss D. Withington, The University, Manchester. Application should be made at an early date, as the holding of the courses depends to some extent upon the number of applications received.

IN any college where a large staff is employed, the duties and interests cover a wide variety of subjects, and the results of research work are often scattered over technical journals and the proceedings of many societies, a procedure which fails to provide an adequate view of the work of the college as a whole. The authorities of the Royal Technical College, Glasgow, have been considering this matter, and have resolved to publish an official journal, which will contain records of the research work done in the college, and thus prove an incentive to junior workers in particular. A copy of the first number of the Journal of the college is now before us, and contains records of eleven researches conducted in the college, representing chemistry, metallurgy and engineering. The name of the editor does not appear, but he is to be congratulated upon the production, and especially upon the useful feature of printing a short abstract of each paper immediately under its title. The research activities of the college may be judged by the articles which appear in this issue. These include papers on some acyl derivatives of hydrazine; the formation and constitution of certain double salts with a review and criticism of van 't Hoff's theory; radio-active substances as indicators with a study of the adsorption of lead and bismuth by ferric hydroxide and the adsorption of thorium by basic ferric acetate and by barium sulphate by this method; the hydroferro- and hydroferri-cyanides of the organic bases and some applications; the separation of the components of petroleum with the view of utilising this commodity as a raw material for chemical industries; the iron-carbon diagram, the copper-zinc system; the petrological and chemical examination of slag and metal samples from a basic open-hearth furnace. These papers are followed by two on engineering subjects which occupy nearly one half of the issue, the subjects are the pipe loss in steam nozzles, and turbine wheel friction, on both of which the Royal Technical College has already given authoritative papers. The last paper deals with the structure and mode of life of the sulphur-bacteria and their value as indicators of pollution. The appearance of this Journal will be welcomed alike by science and engineering workers, and cannot fail to be beneficial to research workers in the college itself.

## Early Science at Oxford.

April 6, 1686. Mr. Aston communicated amendments of ye Treatise *De Moventibus in Fluido*, and Mr. Ash sent a Demonstration of the 2d and 5th books of Euclide, and ye whole doctrine of proportion done more briefly than heretofore; for both which ye Secretary was ordered to returne ye thanks of ye Society.

April 7, 1685. A very rationall Discourse concerning Weather, written some time since by Dr. Garden (by way of Letter to his Friend Mr. Scougall) was read. The Society ordered their thanks to be returned, both to Dr. Middleton and to Dr. Garden, for the communication of so considerable a piece of Philosophy. One passage in Dr. Garden's discourse deducing the Rise and Fall of Vapours from their weight in respect to that of the Air, (intimating, that ye Vapours arise, when specifically lighter, and fall when specifically heavier, than the Air). Mr. President, not denying this to be true, added hereunto, that Subterranean heats, or other ferments, may bear some part in producing this effect; as impelling upwards those Vapours, which, being specifically heavier than the Air, fall again in a little time: An instance of which he gave in ye boyling of Water, where the vapours are forced upwards by the fire placed under the Vessell, and, having lost that impetus, which raised them, and being intensively heavier than the Air, sink down again.

A Letter from Mr. Aston mentioned a Catalogue of Rarities, brought from Ceylon, by Dr. Heerman of Leyden, and preserved according to a peculiar way known to him. A Transcript of this Catalogue is desired. The remaining half of Mr. Leevenhoeck's Letter concerns the Salts of Wine, Vinegar &c, was read.

April 8, 1684. Mr. Ballard discoursed concerning ye Magnetism of Drills, being by way of answer to a letter of Mr. Aston's on that subject, dated March ye 15th. Six or seven severall Drills were caused to be made before my face; and ye bit, or point, of every one became a North Pole, onely by ye hardning, before they ever came to be workd either in Iron, or any other Matter. That peices of plain Iron in shape like Drills (that is something long, and small,) do always change their Poles, as they are inverted (ye end downward being over ye North Pole) he finds not always true. Mr. Hunt's experiments on drilling were repeated, but his conclusions were found not to be always confirmed. Mr. Bernard read a letter of his to Dr. Huntingdon, concerning ye place of ye fixed starrs, as treated of in severall Arabic authors, given to Merton College Library by ye Doctor.—There being some discourse concerning ye insipid tast of ye Ice of Seawater, it was queried, whether sea-water might not be sweetned, and rendred serviceable.

April 10, 1688. The Standards of the wine, corn, and Ale Gallons, kept at St. Marys, were examined by Dr. Bernard, Mr. Walker and Mr. Caswell. They were filled with Pump-water, and then weighed. The weights compared with a former experiment by this Society of the weight of a cubic foot of water, give the quantitys of these Gallons in cubic Inches, &c.

Wine—Gallon -	-	232 : 00	} cubic Inches.
Corn—Gallon -	-	270 : 43	
Ale—Gallon -	-	280 : 15	

The variation of the Needle at Oxford July 22nd 1687 was found to be 5°20' West.

Dr. Bernard presented the Society with his book *De Ponderibus et Mensuris Antiquis*; for which the Society returned their thanks.

## Societies and Academies.

LONDON.

Royal Society, March 26.—O. W. Richardson and T. Tanaka: Regularities in the secondary spectrum of hydrogen. It has been possible to arrange 123 additional lines provisionally in 22 series. Three of these form a PQR combination. The present indications are that the moments of inertia of the emitters are spread fairly well over a range extending from the high value deduced from the PQR combination found previously to a value somewhat below the lowest value which has been deduced from Fulcher's second band. This involves an extreme variation by a factor of almost six in the moments of inertia.—S. Chapman: The lunar diurnal magnetic variation at Greenwich and other observatories. The systematic changes of magnetic declination at Greenwich, during the course of the lunar day, have been determined from hourly records extending over 63 years. This and other magnetic elements have been similarly studied, using shorter series of data, for the observatories of Batavia, Zikawei, and Pavlovsk. The character and magnitude of the lunar daily changes depend on the following factors: the position of the sun relative to the moon, the position of the sun relative to the equator, the distance of the moon, the sunspot epoch, and the general state of magnetic activity upon the earth—the latter being connected with particular disturbed regions on the sun's surface. The lunar daily magnetic variation varies much less with sunspot epoch, and much more with the magnetic activity, than does the solar diurnal variation. It is concluded that the lunar influence on the earth's magnetic field, exerted through the agency of the lunar tide in the earth's atmosphere, is most efficient in the polar regions.—H. T. Flint: A general vector analysis with applications to electrodynamical theory. The vector analyses in use, as a rule, are concerned with quantities represented by straight lines, and the space to which they are applicable is Euclidean. An account is given of an analysis in which a vector is represented by

$$\delta \mathbf{a}' = \sum_n \delta x^n \mathbf{e}_n.$$

The vector is of infinitesimal length and  $\delta x^n$  represents a component measured in any system of co-ordinates. In any kind of space, Euclidean or not, in which a point B has co-ordinates  $(\delta x^1, \delta x^2, \dots, \delta x^n)$  with respect to A we shall regard  $\delta \mathbf{a}'$  as denoting a definite quantity, whatever the system of co-ordinates. In this space we shall suppose the geodetics unique and shall regard the geodetic arc joining A and B as the geometric representatives of the vector  $\delta \mathbf{a}'$ . So far as possible the notation will be similar to that of Gibbs' vector analysis. The notation may be applied to space of any dimensions, but four-dimensional space is taken as fundamental. In many cases it is possible to employ a notation that leaves the formulæ of ordinary vector analysis almost unchanged, and formulæ of the restricted principle can be carried over to the general principle by merely applying rules of generalised vectors.—Miss M. O. Saltmarsh: The spectra of doubly and trebly ionised phosphorus (P III and P IV). The series system in the spectrum of doubly ionised phosphorus is a doublet system in accordance with the spectroscopic displacement law. Three members of the triplet series of the spectrum of trebly ionised phosphorus have been identified. For three groups of elements, each having its own characteristic electron structure, the sharp terms are greater than the diffuse terms with the same Rydberg number for the neutral and singly ionised element, but for higher stages of ionisation the diffuse terms are greater than

the sharp.—D. M. Wrinch and J. W. Nicholson: Laplace's equation and the inversion of surfaces of revolution.—T. R. Merton and J. G. Pilley: On experiments relating to the spectrum of nitrogen. When helium at about 30 mm. pressure containing a very small quantity of nitrogen is excited by feebly condensed discharges, the arc spectrum of nitrogen is developed, and under these conditions is completely isolated from the spark spectra. The arc spectrum of nitrogen is not developed in the presence of an excess of argon under the same conditions in which it appears in the presence of helium. Special precautions have to be taken to ensure the purity of the gases. When nitrogen is excited by electron impacts there appears to be a direct transition as the energy of the impacts is increased from the negative band spectrum to the spark spectrum, which would imply that the rupture of nitrogen molecules is generally into ions rather than neutral atoms.—T. H. Havelock: Studies in wave resistance; the effect of parallel middle body. The ship is altered by inserting varying lengths of parallel middle body between the same bow and stern. The main problem is the study of the equivalent wave-making length of the ship, and its variation with velocity and with the length of parallel middle body.—T. Tanaka: Wave-lengths of additional lines in the many-lined spectrum of hydrogen. Some 560 new lines in the secondary hydrogen spectrum have been measured. Incidentally it was necessary to make measurements of a considerable number of lines in the oxy-hydrogen band spectrum.—H. S. Taylor: A theory of the catalytic surface. A catalytic surface seems to be composite, of atoms in varying degrees of saturation in a crystal lattice. The saturation varies from that in a plane surface to those which are only held to the surface by a single constraint. It is by this constraint that these outermost atoms differ from gaseous atoms. Thus several molecular species, for example, hydrogen and an unsaturated molecule, may be attached to the same atom of catalyst.—E. F. Armstrong and T. P. Hilditch: A study of catalytic actions at solid surfaces. Pt. XII. Some observations relative to those particles of a catalyst which participate in chemical change. The rate of decline of activity of several nickel catalysts in the presence of varying concentrations of impurities characteristic of natural fatty oils has furnished evidence supporting Taylor's hypothesis (*v. above*). The active nickel atoms seem to be actually detached from their neighbouring metallic atoms during the moment in which catalytic change is effected. Pt. XIII. Some factors controlling selective hydrogenation with particular reference to certain terpene derivatives. Whilst adjacent (conjugated) ethylenic linkages are converted completely to a saturated system, two separate ethylenic linkages are hydrogenated consecutively, one double bond disappearing completely before the other is attacked: acetylenic linkages are transformed to the saturated compounds with little or no production of the corresponding ethylenic compound. Similarly, the hydrogenation of esters or glycerides of polyethylenic higher fatty acids (but not the free acids themselves) is markedly selective, and the same applies to diethylenic derivatives of the terpene series. Selective hydrogenation, observed by ourselves and by Vavon, in compounds such as carvone, limonene, citral, geraniol, and linalool, is determined mainly by (i) degree of substitution of ethylenic carbon atoms, and (ii) proximity to one or other double bond of a carbonylic or hydroxylic group. It is also deduced from these results that citral, geraniol, and linalool all contain the grouping  $(\text{CH}_3)_2\text{C}=\text{CH}-$ . Selective hydrogenation is of considerable importance in relation to the general theory of catalysis at a solid surface.

Royal Anthropological Institute, February 10.—J. Reid Moir: Further discoveries of Early Chellean flint implements from the Cromer Forest Bed of Norfolk. The principal site investigated exists at East Runton, where, upon the foreshore exposed at low water, is a bed, averaging 18 inches in thickness, resting upon the chalk and very strongly impregnated with salts of iron. The deposit is being slowly broken up by modern sea action, and this results in the formation of a flint bed of a precisely similar character to that present upon the foreshore at Cromer. The accumulation represents in all probability the basal layer of the Cromer Forest Bed strata. From East Runton, Mr. Sairn of Cromer has found a number of Forest Bed mammalian remains, including *E. meridionalis*, *E. antiquus*, *Rhinoceros etruscus*, *Bison bonasus*, *Equus stenonis*, *Hyæna crocuta*, *Trogontherium cuvieri*, and numerous remains of the Cervidæ. The hand-axes recorded at East Runton and Cromer show that the pieces of flint from which they were made were struck off larger masses of flint, some of which were "prepared" by flaking beforehand. The evidence at East Runton establishes the fact of the occurrence of Early Chellean hand-axes in a bed at the base of the Cromer Forest Bed series of deposits, and beneath the glacial boulder clay of the Scandinavian ice-sheet, representing the second glacial period of East Anglia. It is highly probable that the specimens found upon the foreshore at Cromer were derived from a similar deposit to that still existing at East Runton.

February 20.—L. H. Dudley Buxton: The Stoney Indians of the Bow River, Alberta. The Stoney Indians are a branch of the Dakota Sioux, from whom they separated shortly before 1640. After leaving the parent stock they joined the Crees and gradually moved in a north-westerly direction. The reserve on which they now live lies on both sides of the Bow River, in southern Alberta, at an altitude of over 4000 feet above sea-level, in the foothills of the Rockies. The country is hilly and much of it is covered with grass and, in places, low scrub. The area of the reserve is just under 140 square miles, of which fifty acres only are cultivated. The total Indian population is just over six hundred. The Stoneys are divided into three bands, which are not endogamous, but the tribe, apart from a certain admixture of Cree blood, have kept themselves very much from outside contact. They are typical Plains Indians. They are very averse from agriculture, but hunt and trap at the right season and do a certain amount of trading. Although they are mostly nominal Christians, a number of the old customs, notably the Sun Dance, are still retained. The Stoneys seem in their physique to resemble closely the Siouan peoples to whom they are linguistically allied, but the most close resemblance is with the Blackfoot.

Linnean Society, February 19.—Miss A. Lorrain Smith: Templeton's drawings of lichens and fungi. John Templeton (1766–1825) was well known to the botanists of his day, more especially in Ireland. Taylor states in a note to the section *Lichenes* in the "Flora Hibernica" (1836): "The foregoing account of the lichens of Ireland would have been still more incomplete, but for the extensive collections of our lamented friend, the late Mr. John Templeton of Cranmore, near Belfast." Templeton entered on the scientific study of botany in 1790. His last paper seems to have been on peat-bogs, and was contributed to the Geological Society in 1821. Several manuscript volumes of his Hibernian flora with coloured drawings are preserved in the Belfast Museum.—J. Burt-Davy:

The tropical element in the arborescent flora of the Transvaal. The geographical distribution of 647 kinds of trees and allied shrubby plants was discussed. About 30 per cent of these are endemic to the Transvaal and 70 per cent. are "wides." The percentage of endemics is only about two-thirds that of the endemics of all Transvaal phanerogams, suggesting that they represent types of vegetation older than many of the herbaceous types. Fully 90 per cent. of the wides are tropical or subtropical; the temperate element is very small. There is evidence in a limited area of the evolution of a recent warm-temperate flora (through recent elevation of the land-surface) replacing an older tropical and sub-tropical flora. Islands and reefs of older floras are left stranded where climatic conditions permit them to persist; these are not homogeneous, but represent different migration periods. Several cases are cited of strictly Northern Hemisphere genera migrating into South Africa, e.g. *Salix*, *Dianthus*, and *Juniperus*, none of which can have migrated from south to north. The highway of migration southward has been the great eastern mountain-range, owing to its favourable climatic conditions (relative absence of drought periods, etc.). The great central plateau has acted as a (recent) barrier to migration, probably owing to relatively low rainfall and periodic drought — R. R. Gates: A virescent *Delphinium*. The numerous flowers showed little variation, the sepals were large and baggy, the spur of the posterior sepal being very short, forked at the tip, and very late in developing. The petals were very much reduced and without spurs or nectaries. The andræcium was unaltered and the pollen normal. The carpels were long, curved, and without stigmatic surfaces. Virescence is frequently inherited as a Mendelian recessive, but often with complications, and the whole phenomenon deserves further genetic study.

Geological Society, February 25.—A. H. Cox: (1) The geology of Cader Idris (Merionethshire). Cader Idris is an escarpment of Ordovician igneous rocks south of the Harlech Dome. The strata have a general southward or south-eastward dip of about 40°, and the succession is given. The volcanic rocks have a much greater time-range than had been proved hitherto. The four volcanic groups are separated one from the other by sediments of thicknesses so considerable that each represents a distinct episode. The main structures have a north-east to south-west trend; but there is also a regular system of north-and-south minor folds that often cause a marked deflexion of outcrops. This minor folding was operative in pre-Ordovician, Ordovician, and post-Silurian times. (2) The dissection of pitching folds. By altering the inclination of the plane of dissection across a pitching fold, outcrops can be made to take any desired curve, either concave or convex. In a pitching anticline the curves will have a downward convexity when the inclination of the dissecting plane is less than the angle of pitch, but an upward one when the direction of inclination of the dissecting plane is opposed to that of the pitch. There must, therefore, be some intermediate position in which the outcrop "curve" is such that its projection on the map appears as a straight line, and the outcrop crosses the fold without apparent deflexion. Such deceptive projections are liable to occur in districts of high relief.

PARIS.

Academy of Sciences, February 16.—A. Lacroix: A new type of eruptive alkaline rock.—G. Kowalewski: Plane groups with two fundamental infinitesimal transformations.—Angelesco: Polynomials con-

nected with those of M. Appell.—**André Roussel**: Semi-continuity.—**A. Alayrac**: Study of the *vol plané* in a wind of oscillating direction and in an oscillatory wind of short period.—**André Metz**: The entanglement of the ether and the aberration of the stars. The conclusion is drawn that the aberration of the stars, as shown by experiment, is incompatible with the hypothesis of the entanglement of the ether by the earth.—**Louis de Broglie**: The natural frequency of the electron.—**A. Marsat**: The verification of reflectors for the projectors of motor-cars. A description of a rapid method for determining the dimensions of the caustic curves of reflectors.—**A. Leduc**: Molecular association and the equation of state of gases.—**H. Buisson** and **C. Jausseran**: The spontaneous reversal of the lines in the spectrum of neon. In a neon spectrum, lines which are simple when viewed through a short length of gas show reversal when viewed through a longer length. As a consequence of this spontaneous reversal, neon lines are not so useful in determining standards of length as has been supposed.—**André Broca**: The rational mounting of stringed instruments. Modifications in mounting are described which have been proved practically to lead to improved tone and quality.—**Robert Castagné**: The radioactivity of some springs of Alpine stations (Aix-les-Bains, Challes-les-Eaux) in the Pyrenees (Bagnères-de-Bigorre) and the Cévennes (Lamalou-les-Bains, Balaruc-les-Bains, Les Fumades) and of the natural gases of Vergèze (Gard), of Hérépian and Gabian (Hérault). The results of the measurements given show the high radioactive power of the large springs at Aix-les-Bains, the important radioactivity of the waters in the Pyrenees, and the feeble radioactivity of the springs in the Cévennes and on the Mediterranean coast.—**René Audubert** and **Mlle Marguerite Quintin**: The mechanism of adsorption of ions.—**F. Wandenbulcke**: The rapid estimation of sulphuric acid in waters.—**A. Kling** and **Mme. A. Lassieur**: The separation of zinc and nickel by sulphuretted hydrogen. Since the presence of sulphuretted hydrogen interferes with the working of the hydrogen electrode, the quinhydrone electrode and with coloured indicators, it is necessary to remove this gas completely from solutions, either by boiling or by passing air, before determining the acidity. For the quantitative precipitation of zinc as sulphide without separation of nickel the  $P_{H_2}$  must be between 1.35 and 2.—**Georges Denigès**: The alloxantin reagent, of very general application, for ferric iron.—**J. F. Durand** and **R. Naves**: The action of hydrogen peroxide on the magnesium arylamines. By using an anhydrous ethereal solution of hydrogen peroxide, phenylhydroxylamine can be prepared from  $C_6H_5 \cdot NH_2$ .  $MgBr$  with a yield of about 80 per cent.—**Paul Jodot**: Contribution to the petrographic study of *charilles*.—**Jean Piveteau**: The age of the lowest layers of the sedimentary strata of the south-west of Madagascar, between Onilahy and Mangoky.—**J. Savornin**: The cretaceous basin of the Haute-Moulouya.—**R. Bureau**: Atmospherics: their classification and their thermodynamical properties.—**L. Lutz**: The culture of Hymenomycetes fungi in artificial media.—**V. Vincent**: The action of the carbonates of the alkalis and alkaline earths on the acidity of soils. The best substance for neutralising acidity in soil, in spite of its insolubility, is calcium carbonate, because it can be employed at any period without endangering the seed, and is also safer for light soils than quicklime.—**Mlles. J. Lelièvre** and **Y. Ménager**: The application to *L. flexicaulis* of the method of analysis by combustion.—**L. Herrera**: The presence of silica in incinerated histological sections. Remarks on a note by M. A.

Policard. Claim to priority.—**A. Maubert**, **L. Jaloustre**, **P. Lemay**, and **G. Andreoly**: The catalytic properties of bismoxyl. The tartrobismuthate of potassium and sodium precipitates the catalase of hepatic extracts: the precipitate formed shows great activity towards hydrogen peroxide.—**A. Rochon-Duvigneaud**, **E. Bourdelle**, and **J. Dubar**: Apparatus for the determination of the visual anatomical field by the method of the trans-scleral image.—**E. Hédon**: Life without the pancreas. The effects of the suppression of the treatment by insulin in the dog completely deprived of the pancreas: diabetic coma, its cure by sodium bicarbonate and insulin.—**Raoul M. May**: Relation of the nerves to degeneration and the regeneration of the gustative papillæ.—**Jacques Pellegrin**: African fishes of the family of the Phractolœmideæ.—**R. Argaud**: The nerve terminations in human cancer.—**H. Bordier**: Experiments in medullary radiotherapy. This treatment has produced marked improvement, and in some cases has cured infantile paralysis. The technique is given in detail.

## ROME.

**Royal Academy of the Lincei**, January 4.—**V. Volterra** in the chair.—**B. Grassi**: Androphilic and androphobic gnats of Legendre.—**Alfonso Herrera**: Photosynthetic theory of the origin of life and production of organic forms with metaformaldehyde. Under certain conditions formaldehyde undergoes polymerisation into metaformaldehyde, which separates in a pseudo-crystalline mass composed of microscopic cell-like and amœboid forms; the silica present as impurity in commercial formalin apparently plays a part in this phenomenon.—**Ferruccio Zambonina** and **Guido Carobbi**: Isomorphism between tervalent thallium and rare-earth metals. As would be expected from the atomic structure proposed by Bohr, the isomorphism existing between compounds of tervalent thallium and those of the rare-earth metals is of limited range.—**G. Bisconcini**: Imperfect flexibility of ropes.—**Mario Crenna**: Observations on the variations in the latitude of Campidoglio.—**R. Magini**: Behaviour of empty [so-called "sandwich"] cathodes in the electric discharge at low pressure.—**Paolo Straneo**: Expression of hereditary phenomena. Deformation of materials is discussed in relation to previous stresses.—**Emanuele Quercigh**: Bismuthinite. Crystallographic measurements of artificial crystals of bismuthinite lead to the axial ratios,  $a : b : c = 0.985 : 1 : 1.004$ .—**Francesco Ranfaldi**: Ethyl ester of phenyl-*p*-nitrocinnamic acid. This substance forms crystals belonging to the prismatic class of the monoclinic system, the crystallographic constants being  $a : b : c = 1.65679 : 1 : 1.83480$ ,  $\beta = 69^\circ 29'$ ; Scacchi's results for the corresponding methyl ester are modified to:  $a : b : c = 1.82871 : 1 : 0.91775$ ,  $\beta = 69^\circ 29'$ .—**Umberto D'Ancona**: Investigations on the growth and sexual maturity of *Alosa finta* (Cuv.).—**Primo Dorello**: Function of the digitated glands in the genus *Helix*.—**L. La Face**: Observations on the nutrition of *Culex pipiens*.—**Luisa Volterra**: Further notes on the variability of the pelagic daphnias of Lake Nemi.—**N. Passerini**: Influence of the quality of the food on the growth of the larvæ, and on the metabolism, of *Tenebrio molitor* L.

## VIENNA

**Academy of Sciences**, January 15.—**L. Siegl**: Communication from the Radium Institute, No. 174. The quantitative measurement of radium emanation in the guard ring plate condenser. In an attempt to make the radium standard and normal solutions superfluous, a measurement was made of the ionisation





SATURDAY, APRIL 11, 1925.

## CONTENTS.

	PAGE
The Universities and International Relations . . . . .	521
Looking into Things . . . . .	523
British Earthquakes. By R. D. O. . . . .	524
Psycho-Analysis Applied to Children. By M. C. . . . .	525
A Mystic Poetess of Ancient Kashmir. By S. M. Edwardes . . . . .	526
Our Bookshelf . . . . .	527
Letters to the Editor :	
Hydrography of the <i>Dana</i> Expedition.—Dr. J. N. Nielsen . . . . .	529
Absolute Seismometry: a New Method.—Prof. Paul Kirkpatrick . . . . .	530
The Positive Electrical Drift in the Air.—Dr. William C. Reynolds; Dr. C. Chree, F.R.S. . . . .	531
Experimental Study of the "Soaring" of Albatrosses. P. Idراع . . . . .	532
Bio-Chemistry of Muscle Contraction.—W. E. Garner . . . . .	532
Ether and the Metaphysical Mind.—F. F. P. B. . . . .	533
The Migrations of the Painted Lady Butterfly.—C. B. Williams . . . . .	533
The Spectrum of Potassium excited during its Spontaneous Combination with Chlorine.—L. A. Ramdas . . . . .	533
Heterogeneous Catalysis.—Prof. J. R. Partington . . . . .	534
Influence of Radiation on Ionisation Equilibrium.—Dr. J. Woltjer, Jr. . . . .	534
Bushman Rock Figures — Sir Flinders Petrie, F.R.S. . . . .	534
On the Resonance Radiation from Thallium Vapour.—Prof. A. L. Narayan and K. Rangadhama Rao . . . . .	534
The Migrations of the Painted Lady Butterfly. By C. B. Williams . . . . .	535
Further Evidence regarding the Correlation between Solar Activity and Atmospheric Electricity. By Dr. Louis A. Bauer . . . . .	537
Obituary :—	
Prof. A. Dendy, F.R.S. By S. J. H. and Dr. Geo. P. Bidder . . . . .	540
Current Topics and Events . . . . .	543
Our Astronomical Column . . . . .	546
Research Items . . . . .	547
Submarine Measurements of Gravity . . . . .	550
Factors influencing Growth in Trees and Plants . . . . .	550
Haddock Biology . . . . .	551
University and Educational Intelligence . . . . .	551
Early Science at Oxford . . . . .	552
Societies and Academies . . . . .	553
Official Publications Received . . . . .	556
Diary of Societies . . . . .	556

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The Universities and International Relations.<sup>1</sup>

AT a meeting of the British Academy held on February 25, Lord Balfour, Dr. J. W. Mackail, Sir Henry Newbolt, and Sir Rennell Rodd spoke in support of the endowment fund appeal of the British Institute of Florence. The publication of reports of these speeches has attracted general attention to the enormous importance of cultural relations between civilised peoples in view of what is to-day the supreme interest of European civilisation—the establishment of conditions of genuine and enduring peace and goodwill between the nations. Universities are concerned with these relations, first as subjects of study and research, and secondly as responsive to influences which the universities can and do exert on them. It is mainly the latter aspect with which we are at present concerned, but limitations of space prevent more than a passing reference to the influence of vacation courses for foreigners.

Year by year visitors from nearly every civilised nation come to study in British universities. Since 1920 a census has been taken annually in October of students from other countries in the universities and university colleges of Great Britain and Ireland, and it has been ascertained that their total number at that season of the year is between four and five thousand. It has varied but little from year to year. Most of them come at an age at which, whatever its prejudices, the mind is receptive to new impressions. They come eager to learn, many of them hold scholarships awarded on the ground of exceptional capacity for learning, and many assume, after they have returned, leading positions in politics, administration, education, commerce, and industry in their own countries. The character of the impressions they receive is, therefore, a matter of no small importance. A very telling phrase, indicative of the importance of such impressions, was used by a professor of Harvard medical school when, speaking as exchange professor at Berlin in 1912, he described how, owing to his studying in a German university, he had become an "intellectual subject of Germany."

The universities of Great Britain and Ireland receive also from time to time university teachers from other countries. Such visits are generally for the purpose of delivering one or two lectures, and accordingly brief. In the few cases in which they extend over a whole term and the visitor has opportunities of entering fully into the life of the university, as in recent exchanges between

<sup>1</sup> *The Educational Record* (Quarterly Journal of the American Council on Education, Washington, D.C.), January 1925,—article on International Relations, by Dr. D. A. Robertson. "Syllabus on International Relations," by Dr. P. T. Moon (The Macmillan Co., 1925, pp. 276), issued by the Institute of International Education, and to be followed shortly by a companion volume designed to appeal to the general reader as well as the college student. *Documents concernant l'expansion scientifique et universitaire de la France* (Paris, Les Presses Universitaires de France, 1923).

Bâle and Cambridge, Bâle and Manchester, Cape Town and Liverpool, and Harvard and Oxford, they are capable of contributing substantially towards the promotion of good feeling between the countries which they represent.

The number of British students who resort to foreign universities for study and research has not been ascertained. Apart from attendance at summer vacation courses in language and literature, it is probably not large. During the past few years, however, a rapidly increasing flow of British students to the United States has been created by the institution of a number of fellowships and scholarships, notably those of the Commonwealth Fund, and the Laura Spelman Rockefeller, the Frances Riggs, the H. P. Davison, the Jane Eliza Procter, and the Clarence Graff foundations. When these are in full operation they will maintain some seventy British students in American universities.

During the War we were roused to a perception of the importance of fostering cultural relations with other countries. For a time "propaganda" was a word to conjure with, and the things for which it then stood were given a recognised place in our defensive armoury. Plans were worked out in detail for establishing a book distribution depot and a number of institutes in Continental countries, for encouraging the study of the English language and literature. These plans were about to be put into execution when the War came to an end, and, in the general retrenchment of establishments which ensued, they were hastily abandoned as being superfluous in time of peace. With the single exception of the British Institute at Florence, which is entirely independent of Government support, we have no establishments in European countries charged with the duty of diffusing knowledge of British civilisation.

Another war-time plan with similar objectives was devised by Lord Balfour in consultation with the universities of the United Kingdom in May 1918. This plan, for sending a Universities Mission to the United States, did not depend on the creation of any official machinery and was forthwith carried into effect. The missionaries sowed their seed and left it to thrive or perish as might be, bringing back with them a great store of knowledge of American universities, in the acquisition of which they had established many friendly personal relations. The precedent thus set was followed by missions, similar but on a smaller scale, to France and to Belgium in 1919, and a conference of British and Swiss universities at Bâle in 1922.

Although it was no part of the plan for the Mission to the United States to create any permanent organisation, Lord Balfour took the opportunity of pressing upon the universities the desirability of an "organ of expression" which should, among its other functions, represent them

in their relations with the universities of other nations. The suggestion bore fruit in the constitution of a standing committee of the executive heads of the universities of Great Britain and Ireland, the existence of which facilitated the organisation of the later missions.

As a result of discussions arising out of the report of the Mission to the United States, a committee of the Universities Bureau was formed for the purpose of promoting interchange between teachers and students of the home universities and those of the universities of the United States and also of other parts of the world. With no funds at its disposal, and no prospect of obtaining any to meet the expenses incidental to such interchanges, the committee could not be expected to achieve much: nor, in fact, did it.

In matters of this kind, countries with autonomous universities are at a disadvantage compared with those in which the universities are controlled by the State, as in France and Italy. In March 1919 the Ministers of Public Instruction of these two countries concluded an agreement for the organisation of exchanges of professors and students "afin de rendre les relations intellectuelles des deux pays plus étroites et de mieux faire connaître de part et d'autre leur développement littéraire, scientifique et pédagogique." Later in the same year, agreements with the Ministers of Public Instruction in Rumania and Jugo-Slavia provided for seconding French professors for service in those countries. Agreements made by the French ministry in 1921-1923 with Belgium, Luxembourg, Poland, and Czecho-Slovakia provided not only for systematic interchange of professors and students and reciprocal recognition of studies, diplomas, and professorial service, but also for the setting up of permanent advisory commissions to ensure constant consultation and collaboration in the domains of scientific, literary, artistic, and pedagogic activity. Grants of money amounting to several millions of francs were obtained from the French treasury for bursaries and for remission of fees to enable foreign students to study in France.

It has been pointed out already that as soon as the War was over, the plans made for establishing British institutes in foreign countries were abandoned, on the ground that their expense was no longer justifiable. In France other counsels prevailed, a higher value being placed on such services. The Ministry of Foreign Affairs, through its Service des Œuvres françaises à l'étranger, and the Ministry of Public Instruction, through its Service de l'expansion universitaire et scientifique, have co-operated with professors and other savants, university councils, comités de patronage d'étudiants, and various associations, in a strenuous and sustained effort to make French culture appreciated by foreigners, an effort financed largely by the State.

Branches of the Office National des Universités et Écoles Françaises have been established in London and New York; the Instituts Français at London, Florence, and Madrid have been maintained, and new institutes opened at Naples, Barcelona, Prague, Warsaw, Sofia, and Buenos Aires; a university mission with 24 professors of lycées and eight professors or lecturers in universities has been established in Rumania.

These establishments have greatly facilitated the interchange of students in various ways. At Prague, for example, the Institute conducted special elementary courses in the French language which enabled lawyers, doctors, engineers, artists, and scientific workers to qualify for French government bursaries. The New York director of the Office National reported in November 1922 that he had placed in the universities, colleges, and schools of the United States as professors of French 115 former bursary holders. During the previous year the number of French bursary holders in American institutions was 62 and the number of American bursary holders in France 60, while 116 students were recruited by the Office for study and travel in France. In 1922 there were 1392 Americans studying at French institutions as compared with 407 at British. The total number of foreign students in French universities that year, excluding vacation courses, was about 6000.

(To be continued.)

### Looking into Things.

*Concerning the Nature of Things: Six Lectures delivered at the Royal Institution.* By Sir William Bragg. Pp. xi+232+32 plates. (London: G. Bell and Sons, Ltd., 1925.) 7s. 6d. net.

TO deal with the "nature of things" as seen by modern physics in a course of six lectures to a juvenile audience is indeed a formidable task, and there are probably few besides Sir William Bragg who could have attempted it with any prospect of success. That success was achieved by the lectures there can be no manner of doubt to any one who had the good fortune to be present. The personal charm of manner of the lecturer and the beauty of his experimental illustrations was a great help, and no doubt many of his audience were carried smoothly along on the stream of his argument, in spite of the fact that the real inwardness of much of it must have been beyond their immediate understanding. The lectures cannot have failed to stimulate a vital curiosity as to the nature of things in some of the young hearers, and may perhaps have laid the foundation of more than one future career to be devoted to the successful deeper delving into that very "nature."

These same lectures, presented in the form of a book, are, however, a much more difficult matter. Cold print has to take the place of the living word, and illustrations, however well done, and descriptions, however clear, can never produce the same effect as actual experiment. To those who have heard the lectures the book must be most welcome as a permanent record in which they can study at greater leisure the facts and ideas put before them. To those reading the book by itself, however, we fear that its contents may prove a little difficult from the "juvenile" point of view. It is, of course, amazing to an older generation how much the more advanced juveniles of to-day are able to assimilate and understand, and possibly to a young mind coming fresh to such a field of ideas there may be less difficulty in following and adopting the writer's line of thought than to an older mind already burdened with many conceptions and some misconceptions. None the less, if one compares the book with the records of similar lectures by Tyndall or Faraday—and it fully deserves such a comparison—it seems to imply a much greater degree of scientific pre-education. To the more mature reader, on the other hand, it offers a delightful presentation of one of the latest developments of physical science in a most agreeable form. The scientific investigator who possesses the somewhat rare gift of lucid and attractive exposition owes a duty to the world to use that gift in order to open up the new fields of discovery to a wider circle, and that duty is beautifully performed in this book.

Broadly speaking, the book deals with the atoms and the ways in which they are arranged or grouped in gases, liquids, and solids. The first chapter deals with the structure and size of the atom, full use being made of the knowledge gained from radio-activity and the ionisation-track method of Wilson. The author takes care to state that the atom cannot be regarded as a hard sphere and describes its "astronomical" construction; afterwards, however, he follows the path of least resistance and speaks and evidently thinks of atoms in terms of spheres having definite sizes—a fiction which, though convenient, is apt to prove very misleading in detail. In the second chapter the nature of gases is discussed, with the aid of many beautiful experiments and analogies, while the third deals with the nature of liquids.

In the remaining three chapters the author comes to his own proper field of research, dealing with the nature of crystals, beginning with the diamond, studying ice and snow, and ending with the metals. Incidentally, however, many other things are touched upon, among them the simpler aspects of the author's own work on the measurement of organic molecules by means of X-rays, which is undoubtedly one of the

most remarkable achievements of that new weapon of physical research. It is not so very long since we still regarded the atom and the molecule as more or less theoretical conceptions the real size and weight of which could only be guessed at roughly. Here we see not only the dimensions and weights of the atoms accurately known, but also their exact arrangement in well-defined crystals as well as in thin layers of complex organic substances such as fats and waxes. The plane diagrams of stereo-chemistry are confirmed and supplemented until we have true three-dimensional models.

Perhaps the only ground for real criticism of Sir William Bragg's book relates to his treatment of the subject of metals and alloys; that particular chapter contains several perhaps minor but unfortunate errors, such as the statement that the addition of nickel to copper does not affect the lattice of copper and does not cause hardening, or that the path of fracture in gold is between the crystals at ordinary temperatures and across them at high temperatures, whereas in reality gold—and all pure metals—normally break across the crystals at all temperatures except within a few degrees of their melting point. A most interesting account is given of the behaviour of crystalline metals under plastic strain, but the reader is left to infer that this was discovered by X-ray methods, whereas it was discovered so long ago as 1899, and there is the further doubt whether it is justifiable to conclude that because X-ray reflections from a thin film of gold show reflections coming from regularly oriented crystals, the film of gold must be entirely or even mainly crystalline. When, however, an author undertakes to deal with "the nature of things" in general, we cannot blame him if he does not prove himself omniscient. The pleasure and profit of the reader—whether juvenile or not—of this book will scarcely be diminished by these things. These readers, and we hope there will be many of them, will share with the scientific world generally a sense of gratitude to Sir William Bragg for having, in this book, done good service in helping to spread the light on "things in general" as physical science now sees them.

### British Earthquakes.

*A History of British Earthquakes.* By Dr. Charles Davison. Pp. xviii + 416. (Cambridge: At the University Press, 1924.) 25s. net.

FOR thirty-five years past Dr. C. Davison has made the subject of British earthquakes his own; he has written numerous studies of individual shocks and groups of shocks, and has now collected these, with much additional matter, into a volume which will always be of value to those who are interested in the phenomena

which used to be called earthquakes, and will continue to be regarded as such by most of us, though the word has acquired a new meaning in modern seismology. By whatever name they may be called, they are a legitimate subject of study, and in this study Great Britain has taken a prominent place, in spite of the limited opportunities of observation; yet these opportunities are not so scanty as is often assumed, for Dr. Davison enumerates 1175 distinct shocks, of which he has found record, up to the end of 1912, nor are they by any means all feeble ones; in 1185 the "great church of Lincolne was rent from the top downwards," and in the Colchester earthquake of 1884, 1245 buildings of various kinds were damaged.

If any fault were to be found with the work, it is that the interpretation of the facts is, throughout, presented in terms of one particular theory of origin. This is openly acknowledged by the author at the outset, where he states that the methods of investigation made use of are based on the theory that earthquakes are the result of successive steps in the growth of faults. It is always unfortunate when a worker limits himself to one theory; theories, even the most strongly established, are ephemeral, and when their time is come, they pass away into the limbo of oblivion; or, to vary the metaphor, they are tools which the workman must use, but should always be ready to discard when they are no longer the best adapted for the job in hand. In some instances the facts seem to be as readily, if not more easily, explicable by a very different theory from that adopted by Dr. Davison, yet it must be acknowledged that, if he has allowed the theory to colour his interpretation, he has not let it distort his presentation of the facts, and some of these are curious. It is not commonly known that the first recorded observation of rotation, without overturning, of objects, was made in London itself, where two china figures in a cabinet, in Bloomsbury, facing westwards before the earthquake of March 19, 1750, were found turned round to north-east, after the shock had passed. In 1816 the octagonal spire of the county jail at Inverness was broken through at about five feet from the top, and the upper part twisted round so that the angles of the octagon stood nearly over the middle of the sides below. These are instances of vorticose shocks, first brought into prominent notice by the report on the Calabrian earthquake of 1783, observed in nearly every great earthquake since then, and for long a subject of controversy.

The most noteworthy impression produced by an examination of the book is that British earthquakes are characterised by the magnitude of the area over which the disturbance was sensible. As in all earthquake catalogues, there are a large number of shocks which only affected areas of a few miles across,

but of the larger ones, in nearly every case, the extent of the disturbed area is markedly greater than is usual, in countries where earthquakes are frequent. To take the case of shocks which attained a maximum intensity of viii° of the Rossi-Forel scale, Dr. Davison enumerates 8 excluding those of early date and imperfect information; of these, in only one case was the disturbed area distinctly less than 50 miles across; the other 7 affected areas of more than 200 and up to nearly 400 miles in diameter. In the case of Italian earthquakes, attaining the same degree of maximum intensity, barely 1 in 20 would affect an area of 200 miles in diameter, and 9 would be limited to less than 50 miles across, the other 10 reaching limits between 50 and 200 miles. No method has yet been published which, in practice, enables the depth of origin to be determined with certainty, but the difference between Britain and Italy, in the extent of country affected by earthquakes of the same degree of maximum violence, shows that the origins of the British earthquakes are, on the average, markedly more deep-seated than those of the Italian.

Many other interesting observations recorded in the volume, which might easily escape notice in a work of its kind, are easy to find, as it is provided with an unusually detailed index. R. D. O.

### Psycho-Analysis applied to Children.

*Love in Children and its Aberrations: a Book for Parents and Teachers.* By Oskar Pfister. Translated from the German by Eden and Cedar Paul. Pp. 576. (London: George Allen and Unwin, Ltd.; New York: Dodd, Mead and Co., 1924.) 24s. net.

IN his preface, Pfister, who is a Protestant pastor in Zurich, notes the difficulties inherent in the exposition of the analytical method to the ordinary reader, difficulties caused by the absence of generally accepted data and by the fact that the details of a single analysis would fill a volume. He claims that his vocation and studies have brought to his notice hundreds of mentally tormented persons in whom aberrations of the emotional life in childhood underlay the torment. Yet scientific psychologists have scandalously neglected this important topic, and "when a new and unfamiliar phenomenon like the activity of the unconscious makes its appearance they take to their heels—at least such has been the behaviour of most of the German psychologists."

After a survey of the handling of the problem by philosophers of different epochs, Pfister plunges into a psycho-analytical study of the manifold aspects of love aberrations in children. Freely illustrated by

actual examples, this study shows Pfister as able to enter easily into an emotional *rapprochement* with his subjects, a *rapprochement* which undoubtedly aids him in obtaining their confidence and co-operation. His accounts of analyses are simply given, and in some cases it is possible clearly to distinguish between the associations of the analysand and the deductions of the analyst—a most important matter for the critical reader. Unless the reader dismisses these accounts as fantastic, they should carry conviction as to the reality of the mental processes concerned in the production of psycho-neurotic symptoms, the variety of which may surprise those unfamiliar with their ramifications: stammering, kleptomania, incontinence of urine, obsessive phantasies, inability to learn a particular subject or to settle down to a career, are a few of the problems that Pfister finds amenable to analytical treatment. Much of the book is devoted to individual cases, which serve to illustrate theoretical principles as they are developed, and the general application of these principles is summed up in the last six chapters, which are easily the most important and most interesting in the book.

Pfister is emphatic in declaring that in every school class there is a notable proportion of children with grave troubles and inhibitions, and that their teachers are in general quite ignorant of how to deal with them. Chapter xxvii. contains common-sense advice as to methods of handling such children, short of analysis, which should help teachers or parents who realise the need for help, but one fears that those who most need it will repudiate the need. The direct application of psycho-analysis to the individual is considered in the next chapter, where Pfister gives what is certainly one of the best popular accounts of psycho-analysis with its aims, difficulties, and limitations. Like most people familiar with unconscious processes, he realises the futility and even danger of "suggestion" when applied without knowledge, but he admits its applicability in certain instances. He shows how Dubois, the chief exponent of methods of persuasion, uses the emotional relationship of patient and physician as a means of alleviating symptoms even when he claims to work upon the intellectual plane. "Auto-suggestion" the author compares with asking a man to lift himself up by his own boot-straps.

There is a tendency to diffuseness and exhortation that may repel some readers, and the translators occasionally betray a lack of acquaintance with English idiom. Perhaps the author goes beyond the popular conception of "love" in making it the basis of the reaction of the individual to his human environment; but many difficulties of the nervous person of any age lie in the inability to come into satisfactory

emotional contact with his fellows, and it is possibly true that the emotion concerned is inseparable from that of love. The book is obviously written by a worker who relies upon his own experience for his deductions; it should be widely read. M. C.

### A Mystic Poetess of Ancient Kashmir.

*The Word of Lallâ the Prophetess: being the Sayings of Lal Ded or Lal Diddî of Kashmir (Granny Lal), known also as Lalêshwari, Lallâ Yôgîshwari and Lâlîshri, between 1300 and 1400 A.D. Done into English Verse from the Lallâ-vâkyâni or Lal-Wakhi, and annotated by Sir Richard Carnac Temple. Pp. xiv + 292. (Cambridge: At the University Press, 1924.) 16s. net.*

KASHMIR, as the author of this erudite work remarks in his introduction, is the home of wise saws and proverbial sayings; and of the latter none are held in higher repute than the Lallâ-vâkyâni, the "Sayings of Lalla," mainly because those sayings, couched in the form of hymns or lyrics, illustrate the Shaiva Yoga form of the Hindu religion on its popular side, and depict by the medium of metaphor and simile drawn from everyday life the actual hopes and fears of the common folk who nominally followed that system of religion and philosophy. Lalla herself, or Lal Ded as she is commonly called, lived in the fourteenth century of the Christian era, and appears to have spent much of her life in wandering about in a nude state, dancing and singing ecstatically. She was, as her verses indicate, a *yôginî* or female exponent of the Yoga discipline associated with the worship of Shiva, one of the two great gods of neo-Brahmanic Hinduism: but while expressing in her life and poems the utmost devotion to this aspect of the Hindu religion, she was influenced to no small extent, as Sir Richard Temple points out, by the ideas and teaching of the Muhammadan saints of Kashmir, chief among whom was Sayyid 'Alî Hamadânî, leader of the Nakshbandî Order of Sûfis. Though no authentic manuscripts of Lalla's poems now exist, the veteran scholar, Sir George Grierson, has succeeded in collating a tolerably complete text of her verses, which were originally composed in a now obsolete form of Kashmiri and were handed down orally from generation to generation, and it is this text which Sir Richard Temple has translated into English verse.

Apart from the actual songs and their rendering, this book is valuable by reason of the admirable survey of the sources of Lalla's religion and of the theory and doctrine of her faith, which the author has prefixed to his interpretation of her hymns. To those who desire a succinct and illuminating exposition of the growth

and nature of the extraordinary medley of magic and metaphysics which we know as Hinduism, Part I. of this work can be confidently recommended, written as it is by one who has steeped himself for fifty years in the history, the antiquities, and the lore of India. Commencing with the Aryan religious instinct, which has a distinctly theistic trend in contrast with the atheistic tendencies of those Asiatic peoples who dwell farther to the East, the author expounds the gradual growth of the Aryan religion and of the old Brahmanic doctrines, which were a blend of "especially developed aboriginal ideas deriving from lands North and West of India with those of aboriginal India itself." He shows how the belief in sacred syllables, *mantras*, and riddles arose, comments lucidly upon the *Upanishads* and the Brahmanic schools of philosophy, and then describes the origin and nature of Buddhism, Jainism, and the Bhâgavat religion, with its great doctrine of *bhakti* or devotion to a personal God, and how the latter joined forces with Brahmanism in its struggle against the atheistic creed of the Buddhist, and so led directly to the identification of the Brahmanic Vishnu with the sole God, Bhagavân. It is observed that Sir Richard Temple dates the death of Buddha "with sufficient certainty" in 488 B.C. There is evidence, no doubt, to support this date; but it is by no means improbable that the date accepted in Ceylon, namely 543 B.C., is correct, particularly as this fits in with the chronology disclosed in the important Hatigumpha inscription of Khâravêla, which at quite a recent date has been subjected to close scrutiny by two leading Indian scholars.

In one respect the author's estimate of the influence of Alexander's invasion upon India seems also open to comment. He attributes to the Macedonian conqueror "the teaching of state-craft on a large scale and generalship to the Indian Chiefs." Such Hellenistic elements as can be detected in Indian civilisation were certainly due indirectly to the invasion, but Indian polity and the caste-basis of society remained substantially unchanged, and even in military science Indians showed no disposition to learn the lessons taught by Alexander. The kings of India preferred to go on as before, trusting to their elephants and chariots, supported by hosts of inferior infantry. It was not until the sixteenth century that any leader appeared to repeat with success the shock tactics of the Macedonian cavalry. The date of the Kushân king, Kanishka, accepted by Sir Richard Temple, is likewise questionable, and it seems reasonable now to place that king's accession in the early years of the second century A.D. These, however, are minor criticisms and in no way detract from the value of the author's survey of the influences which moulded Lalla's religious belief. His account of the gradual permeation

of Hinduism by the Tantric doctrines and the often revolting worship of the *Shakti* or Female Energy, of the influence of Southern Indian Vaishnavism and of the great Hindu revival associated with the genius of Shankarâchârya, and lastly of Islam upon the minds of Lalla's age, is fully in keeping with the remainder of his careful explanatory essay, and must be read by those who desire to follow the author's detailed exposition of the Trika philosophy, which Lalla conveyed to the public in the guise of popular hymns.

As to the actual translation of the hymns, Sir Richard Temple has wisely refrained from adhering slavishly to the literal rendering of Lalla's words, but has endeavoured to convey her meaning in English metrical form, which, so far as possible, is modelled on the roughness and irregularity of the original. In order that the reader may lack no aid to understanding the inspired words of the prophetess, he has prefixed to each hymn or poem a brief and complete explanation of its inner meaning. Sir Richard Temple's work, which is printed and produced in a style worthy of the Cambridge University Press, is a valuable addition to the growing library of books dealing with the religious literature of India. S. M. EDWARDES.

### Our Bookshelf.

*Humanism and Technology and other Essays.* By Principal C. Grant Robertson, Sir Thomas H. Holland, Prof. C. H. Desch, Sir Henry Fowler, Prof. F. W. Burstall, Prof. W. Cramp. Pp. 91. (London: Oxford University Press, 1924.) 3s. 6d. net.

THIS is a brilliant little book and as useful as it is brilliant. The title scarcely does it justice, for the book contains essays dealing with the relations of humanism and science generally and a great deal of admirable good sense on education. The occasion of their composition was a vacation school for engineering teachers held in the University of Birmingham and in Oriel College, Oxford, in the summer of 1923. Mr. Grant Robertson, the Principal of the University of Birmingham, fitly leads off with the most general paper and one of the best things in the book, on "Humanism and Science." The note which he strikes is sustained throughout the volume; both sides of education are needed for the adequate training even of the pure technician. If "humanism" means knowledge of the best that has been thought and felt, how can you omit from the best the finest achievements of the scientific intellect? Conversely, students of science who are to make the best use of their training should have at least such contact with the humanities as is implied in an acquaintance with general history, and in particular with the growth of science in relation to the evolution of human society.

Sir Thomas Holland has a humorous epigram on this point, which must not be pressed too far. "It is not," he says, "separate courses of history and science—a mechanical mixture—that are wanted, but the history of science itself, that is, a chemical compound.

Giving two separate doses of two unrelated subjects to act as mutual correctives is equivalent to giving a man a metallic sodium pill with a sniff of chlorine gas, when what he wants is merely a pinch of common salt." Sir Thomas Holland lays great and well-deserved stress on the value of biography in historical teaching, and would like to try the experiment of covering a syllabus of chemistry or metallurgy by lectures on biography alone. Prof. Burstall is still more definite. He points out that physical science, as we know it, is a product of the last two hundred years, and its practical applications of the last century and a half. Hence he would have the student consider the historical aspect of the development of engineering since 1775, the starting-point of James Watt's work.

This would no doubt be excellent for the engineering student during his special training; but we should like to put in a plea for the earlier history of science as a part of his general education before he begins to specialise. F. S. M.

*The Properties and Uses of Wood.* Prepared in the Extension Division of the University of Wisconsin by Arthur Koehler. (University of Wisconsin Extension Texts: Industrial Education Series.) Pp. xiv + 354. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 17s. 6d. net.

THE author of this book is one of the chief workers in the Forests Products Laboratory at Madison in Wisconsin, which was established by the United States Forest Service in 1910. This laboratory is the largest and best equipped of its kind in the world, and during the fourteen years of its existence has accumulated a large mass of data concerning wood. The work is distributed amongst seven sections—timber mechanics, timber physics, wood preservatives, pulp and paper, derived products (turpentine, tar, charcoal, etc.), industrial investigation, and pathology. The results of the researches at Madison have already led in the United States to closer use of timber, to better manufacturing methods, and to prolongation of the life of wood in service. The enormous saving of material due to new methods will, it is believed, postpone the advent of the timber famine, which seemed a few years ago to be so near at hand.

We are fortunate, then, to have this elementary textbook produced at Madison, as it brings to our notice in a handy volume the more important facts about the properties of wood, and shows us how these properties affect the utilisation of timber. The chapters deal consecutively with the sections outlined above; and a detailed notice of the subjects treated is unnecessary. We may, however, signal some points of interest. The great drawback to the use of wood is its tendency to shrink and swell, from which result warping, checking, case-hardening, and honeycombing in timber, as is clearly shown in the third chapter. The practical devices against these defects are seen in aeroplane propellers, where the wood used retains its shape, although it is subjected to the most varying conditions of atmospheric moisture and temperature. The chapters on modern methods of testing timbers are well done. The U.S. Forest Service recommends, after many tests, the classification of each species of wood into four grades, according to the defects they

contain, and assigns definite working stresses for each grade, as shown in Table xv. of this book.

Air seasoning and kiln drying are dealt with in two chapters. The latter process is becoming more and more employed; and when done properly it shortens the time required and turns out a better product than ordinary air drying. We recommend this book to foresters and to all interested in improved methods of utilising timber and eliminating waste.

*Ethnographie von Makedonien.* Geschichtlich-nationaler, sprachlich-statischer Teil. Mit einem Trachtenbild. Von Prof. Dr. Gustav Weigand. Pp. iv + 104. (Leipzig: Brandstetter, 1924.) 3 marks.

PROF. WEIGAND is well qualified for his task, and has written an extremely interesting work. He brings out one theory which will be novel to most readers, that the Albanians are not the descendants of the ancient Illyrians, but of the Bessi, a tribe of Thracians referred to by several chroniclers. He considers the former a maritime people, whose centre was in the north and west of the Balkans, where they may be traced in the Morlacchi of Zara, Cici of Istria, where the Latin speech still lingers on, and Venetians, all of whom are connected with the authors of the Messapian inscriptions of southern Italy. He thus makes Albanian the modern representative of the old Thracian language, which occupied a position intermediate between the Slavonic and Iranian groups. He considers that the ancient Thracians became thoroughly Romanised, and, with the exception of the Bessi, forgot their tongue; the fact that Bulgarian, Rumanian, and Albanian, although in no way related, all have a postfixed definite article, unknown in any other Latin or Slavonic tongue, he attributes to the influence of the old Thracian language, and adduces a whole series of analogous occurrences; numerous names of places and of plants are explained as survivors of the old tongue. As an example, we may quote Plovdiv as a Bulgarian corruption of the Thracian Pulpidava.

When dealing with the relations between the Bulgarian, Macedonian, and Serbian languages we feel that the learned author has been influenced, in spite of his disclaimers, by his political sympathies. When, for example, on p. 73 he gives a list of Macedonian words which he states are *never* used in Serbian, he is certainly influenced by his greater familiarity with Bulgarian: all the words he quotes may be heard commonly in Yugoslavia, even in the north and west.

*Electrical Design of Overhead Power Transmission Lines: a Systematic Treatment of Technical and Commercial Factors; with Special Reference to Pressures up to 60,000 Volts, and Distances up to 100 Miles.* By William T. Taylor and R. E. Neale. Pp. vii + 266. (London: Chapman and Hall, Ltd., 1924.) 21s. net.

THE transmission of electric power in bulk over considerable distances has brought into prominence many almost purely mathematical and physical problems, the solution of which is necessary for economical design. Except in the case of abnormal working, the transmission lines are not traversed by high frequency currents or "surges" of electrical energy. It is necessary, however, to know how the resistance and inductance are affected in these cases, and there is a demand, therefore, for mathematical knowledge to simplify and

evaluate the requisite formulæ. Considerations of economy also make it necessary to use a very high voltage. But at very high voltages the lines are surrounded with brush discharges which engineers dignify by the name of the "corona" effect. It is essential to know at what pressures these effects begin, and also the power expended in maintaining a corona on transmission lines. It is therefore necessary to know the physics of the phenomenon.

The authors have limited the scope of this volume to the consideration of lines up to 100 miles in length and to working pressures not exceeding 60,000 volts. The introduction of hyperbolic trigonometry is therefore rendered unnecessary. As power systems in Great Britain are included within these limits, at least at present, this book will prove of use in practice. The authors have wisely adopted international notation, and have laid stress on the standards adopted by the British Engineering Standards Association. They give references to practically all the useful literature of the subject.

*Air Ministry: Meteorological Office. British Meteorological and Magnetic Year Book, 1916.* Part 5: *Réseau Mondial, 1916. Monthly and Annual Summaries of Pressure, Temperature and Precipitation at Land Stations, generally Two for each Ten-degree Square of Latitude and Longitude.* (M.O. No. 227g, Tables.) Pp. xiii + 115. (London: H.M. Stationery Office, 1924.) 22s. 6d. net.

THESE results are now available for seven consecutive years, 1910-1916, and with the publication of each additional year the data are becoming of increased value for meteorological and physical inquiries. All the information refers to land stations, no data over the sea being as yet directly obtainable. Observations are given for 440 stations, and most of these are under the control of government meteorological services. The results show that the highest mean pressure for the year, at mean sea-level, is 30.19 in. at Barnaoul and Minousinsk in 53°-54° N. 83°-93° E., the lowest mean pressure 29.45 in. is at S. Georgia in 54° S. 37° W. The highest mean temperature was 85°.5 F. at Berbera, Somaliland, in 10° N. 45° E., the lowest 10° 6 F. at Markovo-sur-Anadyr in 65° N. 171° E. The largest rainfall for the year was 486 inches at Cherrapunji in 25° N. 92° E., which is 76.3 in. more than the average, followed by 269 inches at Akyab, 77.6 in. more than the average. No rain was measured during the year at Puerto de Arica or at Iquique, at both of which stations the average annual fall is 1 mm. The only rain expected at Puerto de Arica is 0.04 in. on the average in January, and at Iquique 0.04 in. in July. Notes are given for each month on the state of the ice in the Arctic Seas and in the North Atlantic.

*Historical Atlas of the British Empire.* Pp. 20. (London: Macmillan and Co., Ltd., 1924.) 1s.

A USEFUL cheap atlas with thirty-nine black and white maps of the British Empire. Most are only in outline, but a few show orographical features. The text consists solely of a chronological list of events bearing on the history of the British Empire from 55 B.C. to the present day. A great many facts have been crowded into twenty pages, but the maps are the best part of the book.

## Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

## Hydrography of the Dana Expedition.

It may interest readers of NATURE to know the results of some of the hydrographical investigations carried out by the Danish *Dana* Expedition, under Dr. Johs. Schmidt, in the Atlantic in 1921-22.

These investigations were begun in the autumn of

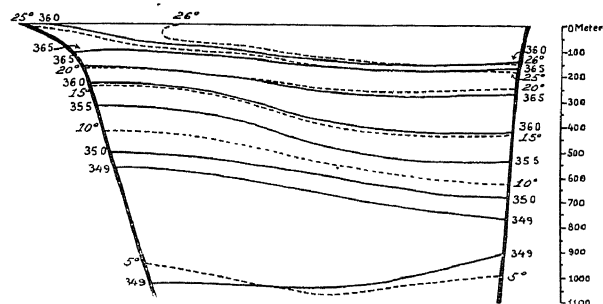


FIG. 1.—Vertical section from Cape Yucatan to Cuba. The dotted curves are isotherms, and the unbroken curves, isohalines.

1921 from the Straits of Gibraltar via Madeira and the Cape Verde Islands to the north-east coast of Brazil; they are of great interest on account of their bearing upon the circulation in the Atlantic.

In the eastern part of the Atlantic, outflowing water from the Mediterranean was found as a characteristic stratum with relatively high temperature, and a salinity maximum at about 1000 to 1200 m., so far south as the Cape Verde Islands (see NATURE, January 12, 1922); in the western Atlantic, on the other hand, a colder water layer was found at a depth of 700-1000 m., with a minimum salinity, showing, indeed, values so low as 34.6 per mille, a stratum originating in the southern part of the Atlantic, and then forcing its way up into the western portion of the north Atlantic.

The section in question intersects the equatorial

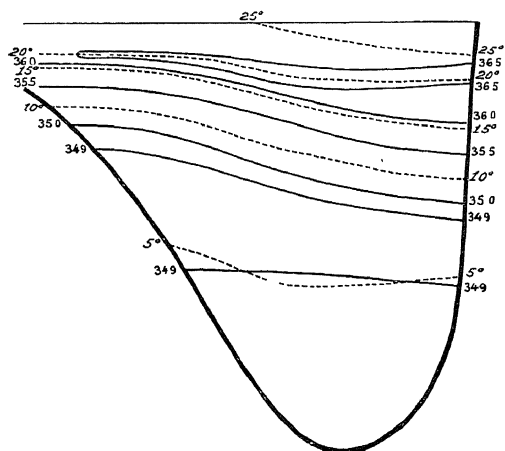


FIG. 2.—Vertical section from Florida to Cuba.

current, which exhibits highly varying salinity at the surface (34-36 per mille); the temperature is high, but decreases rapidly with increasing depth, falling to 10° at a depth of 200-300 m.

<sup>1</sup> All the diagrams are drawn to the same scale.

Part of the equatorial current, with the subjacent south Atlantic water layer, flows into the Caribbean Sea, but the two are here separated by a stratum with high salinity (more than 36.5 per mille) from the Sargasso Sea, which edges in between them at a depth of about 200 m.

These three water layers of different origin flow through the Strait of Yucatan into the Gulf of Mexico, but, as is seen from the sections shown in Figs. 1, 2, and 3, they turn off at once to the eastward along the north coast of Cuba, continuing between Florida and the Bahama Bank. The deflexion due to the earth's rotation causes the isotherms and isohalines to incline to the eastward; the inclination is most pronounced in the Strait of Bemini between Florida and the Bahama Bank, showing that the current reaches its greatest velocity here.

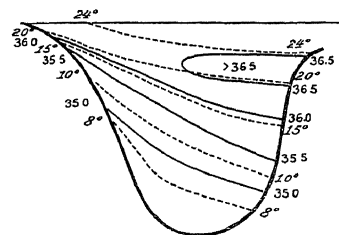


FIG. 3.—Vertical section from Florida to Bahama Bank.

The south Atlantic substratum can still be discerned in the Strait of Bemini, but soon disappears altogether, whereas the two others, namely, the surface layer from the equatorial current and the salt intermediary layer from the Sargasso Sea, form the Gulf Stream or, more correctly, the Florida Current, which flows north-east along the east coast of the United States outside the coast shoal with a velocity probably varying considerably, like the breadth of the current itself, with the season. A value frequently found for the breadth is 60 miles, and the rate of speed may amount to more than three miles an hour.

In a section from Norfolk, Va., towards Bermuda (Fig. 4) the Florida current is sharply defined in the spring, but doubtless becomes somewhat effaced in the course of the summer. In the waters south of Newfoundland, the Florida Current meets the Labrador Current, giving rise to a mixed product with somewhat lower temperature and salinity than are found in the continuation of the Antille Current which

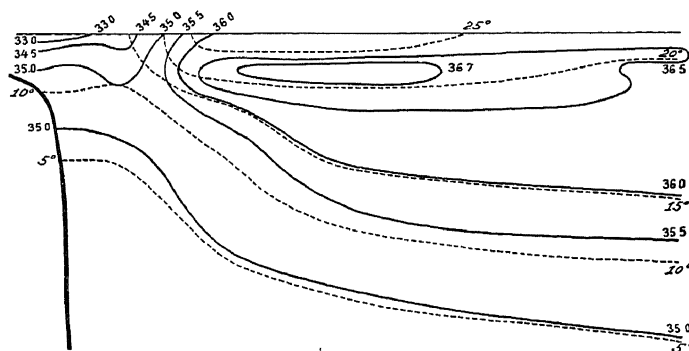


FIG. 4.—Vertical section from Norfolk in a direction towards Bermuda.

runs on the right side of the Florida Current and consists of water masses which keep outside the islands of the Antilles.

Some of the cold water from the Labrador Current flows on toward the south-west, over the coast shoals, and is gradually warmed, but right to the southern

part of the coast shoal the polar origin of the water is still distinctly perceptible.

The mixed product arising from the Labrador and Florida Currents fills the considerable area of sea south of Iceland, while the warm and salt water washing the coasts of north-west Europe is undoubtedly mainly derived from the Antille Current. The term "Gulf Stream" generally employed in European parlance to denote the warm current in the north-eastern part of the Atlantic, must therefore be regarded as inappropriate, since it can only rightly apply to the current off the east coast of the United States, and even this would be better designated by the older name of "Florida Current," as the current in question does not originate in the Gulf of Mexico, but comes from the equatorial region, and covers only the shortest possible distance in the Gulf of Mexico.

A detailed report of the results here summarised will be published in the *Journal of the Royal Danish Geographical Society* for 1925.

J. N. NIELSEN.

Meteorological Institute,  
Copenhagen.

### Absolute Seismometry: a New Method.

THE fundamental problem in all seismometers is to find or devise some observable thing which shall not partake of the earthquake motion. Such a thing is spoken of as a steady point, and the work of a seismograph is to record the position of the steady point relative to the neighbouring earth as a function of time. Unfortunately, most mechanical systems under our observation or control require terrestrial connexion through agencies which inevitably transmit forces, so that steady points are subject to acceleration when their connecting links are disturbed. That is to say, the steady point is steady until the arrival of the earthquake and not longer.

"If one could only be suspended in space near the earth's surface," Hobbs observes, "but without any attachment to it, the problem of registering the earth's motions would be a simple matter. . . ."

"The universal and unsatisfactory substitute for the theoretical unattached observation station outside the earth is the inertia of rest inherent in a suspended mass—the bob of a pendulum. . . . All pendulums have natural periods of vibration which are dependent on their length, and except in the most improved and elaborate instruments they inevitably combine the motions imparted to them by earth shocks with their inherent natural periods of vibration."

The difficulties are like those which a surveyor would encounter if obliged to survey the shore of a lake with only a row-boat as a place to set his transit. Nevertheless, pendulum seismographs in skilful hands give good results. A. Mohorovicic states that by exercise of great care the true local earth movements may be known from a seismogram with a mean error so small as 10 per cent. It is still of interest, however, to consider proposals which offer the possibility of an escape from the earth connexion.

It is stated that astronomers have frequently noted the sudden apparent displacement of stars which were under observation at times of earthquake, and that a seismometer utilising this effect has been proposed. Such an instrument would have the advantage of a truly steady point, but, passing over other objections, would have the limitation of sensitiveness only to rotations and not to translations of the earth particle.

The writer has considered using a freely falling body as "steady point." Such an object is not steady in any sense of being stationary, but it is quite detached from local earth features and will not participate in

any changes of earth motion that may originate within the period of its fall. It would be better to speak of it as an "independent point."

If a body be allowed to fall from a support which has at the instant of release a horizontal speed  $V$ , then after the lapse of time  $T$  the body will have departed a distance  $VT$  from the vertical containing its point of release. If this departure is recorded by a mechanism which shares the motion of the support, then the recorded departure,  $X$ , is given by

$$X = VT - D, \quad (1)$$

where  $D$  is the displacement of the recording mechanism during the interval  $T$ . Expressing  $D$  otherwise, we may write

$$X = VT - \int_0^T V dt. \quad (2)$$

If a continuous succession of falling bodies be observed,  $X$  is a known, continuous function of time and equation (2) suffices to determine  $V$  completely.

Rather than a succession of discrete bodies a continuous liquid jet may well be employed, as has been done in the experiments to be described. A table free to move in one horizontal direction carried a reservoir from which a liquid ran out vertically in a jet which remained continuous for a length of more than three metres. The lower end of the jet passed through a recording device wherein its shadow was cast through a horizontal slit upon vertically moving bromide paper. With the rate of motion of the paper known, the resulting trace gave a complete history of the excursions of the foot of the jet when a disturbance was imposed above.

In order to provide a correct record of the imposed disturbance (limited in this instance to linear horizontal oscillations) a metal pointer was arranged before the slit and mechanically coupled to the moving table so as to reproduce correctly its to-and-fro motions. The shadow of this pointer on the photographic paper left the desired record. Appropriate time-signal shadows were also provided.

These experimental conditions differ from those required by equation (2) in that the recording mechanism does not now partake of the motion of the reservoir. The equation of the trace would now be

$$X = s + T ds/dt, \quad (3)$$

where  $s$  is the displacement of the reservoir orifice at the instant of the release of the particle which is to arrive at the recording mechanism with the horizontal displacement  $X$ . For any series of motions of the source of liquid, two curves should appear on the record, related to each other as are  $X$  and  $s$  in (3). The sample record presented in Fig. 1 confirms this expectation down to the limits of measurement. The broken trace at the top of the figure is a time-signal, being the shadow of a reed which was executing 10.06 complete vibrations per second. The sinuous line next below is the  $s$  curve. Next comes another time-signal, marking seconds, with the shadow of the jet at the bottom of the figure. The sequence of events is from left to right. The record covers a period of twenty-four seconds.

A time interval of something less than a second is to be noted between the initiation of the disturbance at the source and its appearance at the foot of the jet. This interval is  $T$ , the time of fall. The slope of the  $s$  curve is, of course,  $ds/dt$ . Accordingly, if a line tangent to the  $s$  curve at any point be produced toward the right until it shall have progressed from the point of tangency a distance  $T$  in the direction of the time axis, the ordinate of its extremity should, according to (3), be  $X$ . It may be shown from the figure that such is the case.

It was not thought worth the additional trouble to perform a direct test of equation (2). It will be granted at once that a verification of (3) leaves no room to doubt the validity of (2).

Considered as a possible seismographic method, the device presents several interesting features. Two components of motion of a jet are readily registered on one paper through the use of an inclined plane mirror. The apparatus is extremely insensitive to tilts. Its response is to velocity rather than to displacement. The amplitude of the trace may be increased not only by optional magnification but by obtaining a longer time of fall, thus actually increasing the relative movement of the observed mass and its

With a westerly wind the Cannon Street traffic affects London Bridge, and that on Hungerford Bridge can be felt on Westminster or Waterloo Bridges, according to circumstances.

Of the two factors concerned in atmospheric potentials, that is, "the forces of Nature" and the activities of man, the latter appears to me to predominate in the majority of the daily readings in and near the metropolis. To what extent the former intervene can be deduced only from observations conducted many miles from the drift air from locomotives, steamers, road engines, and doubtless other forms of stationary engines. My own measurements point to the sun as the agent in this case.

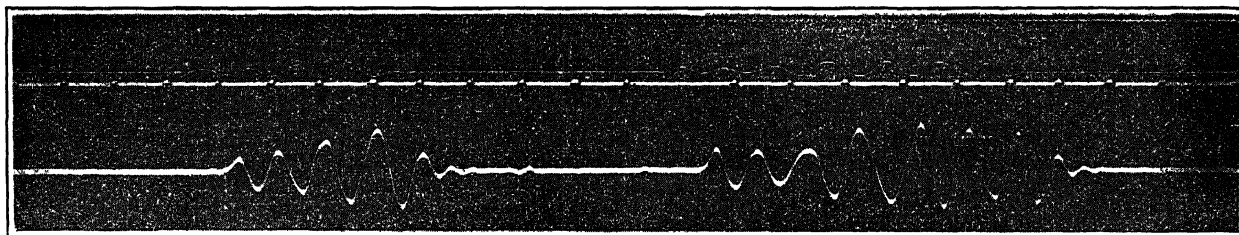


FIG. 1.

surroundings. As in pendulum instruments, we are dealing here with an inertia seismometer, but it is the inertia of motion rather than of rest which it is now proposed to employ.

When the motion of the source is quite rapid the trace does not obey equation (3), presumably because viscosity prevents the fall from being truly free. Viscosity operates at low speeds too, but without measurable effect on the trace. The traces now in hand were made several months ago. It is thought that the liquid used was unnecessarily viscous (some 300 poises) and the jet unnecessarily coarse. Further work is in progress.

PAUL KIRKPATRICK.

Department of Physics,  
University of Hawaii,  
Honolulu, Hawaii.

### The Positive Electrical Drift in the Air.

IF electrostatic measurements are made in the air on a bridge over the permanent way near any railway station, extraordinarily large positive charges given off by steam locomotives will be observed, especially on starting up. These positive charges are carried by the wind for long distances. Under favourable conditions, that is, when the sky was clear and free from interference from clouds, and a stiff steady wind prevailed, I have noticed strong charges down wind a mile away, from a single engine working in a country siding. Scarcely any effect is noticeable in the opposite direction. Similar results, although on a much smaller scale, are observed near steam-driven road engines. They are not noticeable near petrol-driven or electric traction. These charges are presumably similar to those employed in Sir W. Armstrong's hydroelectric machine.

Under any of the large spans covering the railway termini in London, the potential gradient is zero when they are unoccupied. When locomotives are present high potentials are observed.

On some of the bridges over the Thames very high potentials may be observed according to the direction of the wind with respect to railway traffic. At Blackfriars, for example, very strong positive charges are carried by east winds from trains passing to and from Ludgate Hill and neighbouring stations.

The presence of these air-borne charges must necessarily affect the readings at Kew Observatory, surrounded as it is by a dozen stations within a radius of about two miles.

Many readers of NATURE will possess copies of the Royal Society's Handbook of the scientific exhibits at Wembley. In Dr. Chree's admirable article there—a model of popular exposition—curves of the potential gradient at Kew are shown. These curves, with their minima during the early hours of the morning, and their maxima at 8-10 A.M. and 7-9 P.M., would almost stand for traffic intensity curves. The gradient here at Upminster, 17 miles E.N.E. of Charing Cross, when the sky is clear and the wind does not set from the local station, appears to depend principally on London drift air, being very strong with W to S.W. winds and very slight with easterly ones.

In any case, the distribution and influence of these positive charges deserves the careful attention of meteorologists. During hot weather they appear to be dispersed more rapidly than in cold, for a rising barometer and frost result in unusually high concentrations. These drifting positive charges constitute electric currents—in some circumstances these might give rise to compass irregularities. Their irregular distribution may conceivably be connected also with certain kinds of "atmospherics" in wireless.

WILLIAM C. REYNOLDS.

"Whartedale," Upminster,  
February 11.

THE phenomena of electrification in connexion with steam, to which Dr. W. C. Reynolds refers, are described by Mr. W. A. Douglas Rudge in a paper read before the Cambridge Philosophical Society (Proc., vol. 18, p. 127), and referred to in NATURE of November 18, 1915 (vol. 96, p. 332). The breaking up of water, whether the act of man or of Nature (as in waterfalls), is a powerful source of electrification, but I am unable to accept Dr. Reynolds's suggestion that railway steam may account to any large extent for the early morning minimum and evening maximum of potential gradient recorded at Kew Observatory. If this were the case, the change from steam to electric traction in the local trains should have had a profound influence, whereas the daily maximum and minimum

in question seem as marked now as thirty years ago. Richmond station, moreover, is  $\frac{1}{4}$  mile from the Observatory, and is not in the direction from which the prevailing wind blows. It is not a station where much shunting is done. A minimum in the morning and a maximum in the evening have been observed at most places, town and country alike.

Dr. Reynolds is, however, I think, quite correct in believing that electrical phenomena in and near large towns are much influenced by the works of man. Steam no doubt may play an important part in some localities, but atmospheric pollution by smoke is, I think, a much more important factor. Reasons for this belief will be found in the Royal Society Handbook to which Dr. Reynolds refers.

Undoubtedly a continuous record of potential gradient and other electrical phenomena at some really country place, situated desirably to the south-west of London, is a somewhat urgent desideratum.

C. CHREE.

### Experimental Study of the "Soaring" of Albatrosses.

A SERIES of experiments was made by me in Africa in 1920 in order to study the flight of the vulture. Kites were brought into the immediate vicinity of the soaring birds, and carried with them sensitive apparatus, making it possible to find, by means of electrical connexions with registering apparatus on the ground, the variations of internal energy of the air (temperature within  $0.02^{\circ}$  C., pressure within  $0.1$  millimetre; speed, direction, and horizontality of wind variations).

The registrations so obtained showed that in all of the observed cases of flight, the birds used ascending air currents, the origin of which was almost always due to temperature variations; the ascending air columns often shifting according to the temperature variations. The experiments enabled me to measure (by the relation of the horizontal and vertical speeds of the bird relative to the air) the lift/drag ratio of these birds, which is about eighteen.<sup>1</sup>

The soaring of albatrosses and other sea-birds seemed to be quite different. The French Government accordingly sent me on a mission to the South Seas, in the neighbourhood of South Georgia, to study the flight of these birds. Registering apparatus was made use of, either on board of the ship or at sea, by means of floaters left from the board (to avoid the possible perturbations due to the boat). The variations of the internal energy of the air were so studied, as in Africa, amongst birds. Films taken by an automatic cinematographic apparatus, moved by clockwork, enabled me to find out, by photographic reconstruction, the trajectory of albatrosses and their velocity. (The average speed, relatively to the air, was 22 metres.)

The experiments showed that the soaring of albatrosses always takes place when there is no ascending current over the waves and the wind is even; but then it is always observed in the air strata where albatrosses fly, that the wind is *increasing according to the altitude*; doubtless it is the friction of the sea on the wind in the low strata that decreases its velocity.<sup>2</sup> Albatrosses, then, are continually manoeuvring up and down, turning from time to time, going up against the wind and going down with the wind, so

that they alternately put themselves in strata of air of different speeds.

I took numerous measurements in the open sea in order to find out experimentally this variation in altitude of the wind speed that albatrosses use. These measures enabled me to calculate the energy gained by albatrosses.

The results are as follows:

(1) This sort of soaring is possible only for very swift birds. It needs a minimum wind of five metres, close to the water.

(2) The stronger the wind is, the higher (10-15 metres) the birds must do their upper turn.

(3) These trajectories of albatrosses are the most advantageous as regards gain of energy.

These theoretical conclusions are in agreement with the observations. Albatrosses consequently use the slackening of the wind speed due to friction on the surface of the sea.

P. IDRAC.

L'École Polytechnique, Paris.

### Bio-Chemistry of Muscle Contraction.

THE films of long-chain organic compounds (*e.g.* the aliphatic mono- and dibasic acids) crystallised on glass surfaces possess a structure in which the molecules are orientated so that their terminal groups lie in a series of planes parallel to the surface on which they are deposited. This structure is similar to that postulated by Friedel for liquid crystals (*e.g.* soap curds) in the smectic state. In the lamellæ between the planes, the long chains are arranged with respect to the surface at an angle which depends on the nature of the terminal group. For the mono-basic fatty acids the inclination is about  $55^{\circ}$  and for the esters of these acids approximately  $90^{\circ}$ .

Films of aliphatic organic acids when crystallised on glass or on the surface of aqueous alcoholic solutions have been examined by convergent polarised light and found to show the biaxial interference fringes typical of crystal sections in which the acute bisectrix is not normal to the surface. The two optic axes may be accounted for by assuming that successive molecules of acid lie in different directions in space giving rise to a chain of molecules running in a "zig-zag" manner from the surface of the glass. The angle between the chain directions of two adjacent molecules will depend on the configuration of the terminal groups, being different for an acid and its ester and salt.

This type of crystal structure has a possible significance in physiology, for if it be present on the surface of a muscle fibre it would provide a mechanism by which contraction on stimulation could occur.

A striated muscle fibre shows alternate isotropic and anisotropic striæ along its length. On contraction, the width of the striæ decreases, the diameter of the fibre increases, and a tension is produced along the axis. According to Engelmann, the active constituent in producing the contractibility is the anisotropic part of the muscle. The anisotropy is conceivably due to the presence of orientated molecules, presumably of long-chain amino-acids, which are either present in the membrane of the muscle fibre or are distributed in fibrillæ throughout. Assuming for the moment that the membrane is anisotropic due to the presence of long chains of salts or esters of amino acids, and that these are orientated so as to give a zig-zag arrangement of the molecules in a direction parallel to the axis of the fibre, and further consider the effect of converting these salts into amino-acids. In the first place, the

<sup>1</sup> C.R. Académie des Sciences, February 21, July 5, 1920, May 9, 1921; "Études expérimentales sur le vol à voile," par P. Idrac. Thèse de la Faculté des Sciences de Paris 1921. Vivien éditeur, 48 rue des Ecoles; publiée aussi dans L'Aérophile (January, February and March 1922).

<sup>2</sup> C.R. Académie des Sciences, November 21, 1924, "Le Vol des albatross." Vivien, 48 rue des Ecoles. Bulletin de Recherches et Inventions, March 1, 1925: Technique Aéronautique, February 15, 1925.

inclination of successive molecules to one another would be altered just as is the case in the crystalline state when an ester is converted into an acid, and, in the second place, the length of the zig-zag composed of a finite number of molecules would be shortened. If the chains of the molecules commence at the interfaces between the isotropic and anisotropic regions, then the chemical change will produce a tension along the length of the fibre.

When a contraction wave passes along a muscle fibre the hydrogen ion concentration in the muscle increases, due to the production of lactic acid from glycogen, so that the chemical changes occurring during stimulation are sufficient to account for the conversion of a salt into an acid and of an expanded into a contracted molecular film, and hence for the tension along a muscle fibre. W. E. GARNER.

University College,  
Gower Street, W.C.1.

### Ether and the Metaphysical Mind.

DR. JEANS states in his Kelvin Lecture to the Institution of Electrical Engineers, published as a Supplement to NATURE of March 7, that our own physicists have asked for a machine, while "the more metaphysical minds of the Continent have usually been content to accept action at a distance." He goes on to say "it is something more than a coincidence that Newton, Clerk-Maxwell, Kelvin, and Faraday are all British, while Boscovitch, Einstein, and Weyl are not."

Of the three men chosen as typical of the more metaphysical minds of the Continent, all are mathematicians primarily, while two at least of them are of eastern origin—Slavonic or Jewish. These men are therefore representative—if genius is representative of anything—of eastern rather than western Continental thought. Two natural philosophies are apparently now available—a natural philosophy based upon essentially British lines of thought as represented by Newton, Clerk-Maxwell, Kelvin and Faraday, and a natural philosophy based upon an eastern philosophical outlook. Does this not perhaps account for the difficulty that relativists are finding in getting this new plant of eastern origin to take root in British soil? Dr. Merz, in "A Fragment of the Human Mind," pp. 18, 24, 25, etc., has pointed out more than once that when an *impasse* is reached in a discussion of some philosophical question, as, for example, in "Hume's dilemma," it is characteristically British to appeal to common sense.

We appear to be witnessing not so much the birth of a new theory, for there are already half a dozen or more species of relativity theory—Einstein's, Eddington's, de Sitter's, Weyl's, Silberstein's, Whitehead's, Robb's, and so on—as the birth of a new branch of knowledge—*mathematical metaphysics*.

Just as there have always been minds that prefer physics to metaphysics, so there will always be minds that prefer mathematical physics to mathematical metaphysics. The former will draw their inspiration, meantime, from the Larmor-Thomson-Lodge School; the latter from the Einstein-Eddington-Jeans School. The essential distinction between them appears to be that one demands "a machine," *i.e.*, a mechanical (not necessarily Newtonian) model of the physical universe, built in normal space and time; whereas the other is content with describing it through the medium of a mathematical analogue or map. Many of us would be well enough pleased to possess either—the model or the map.

F. F. P. B.

### The Migrations of the Painted Lady Butterfly.

ELSEWHERE in this issue (p. 535) is a short account of our present, very incomplete knowledge of the migrations of the Painted Lady butterfly (*Pyrameis cardui*). This article has been written with the sole object of obtaining co-operation in a problem which can only be solved by the combined efforts of a number of observers who know what to look for and are kept interested by knowing what relation their observations bear to the whole question.

As is stated in the article, only in Western Europe, North Africa, and Palestine is there any possibility of piecing together the hundred or so known records, and even in this area the conclusions will not be trustworthy until the records are ten times more numerous. In the rest of the world, and particularly just to the south of the Palaearctic Desert belt, in Nigeria, Senegal, and the Sudan, for example, every record is of the greatest value, and any one may help to give the clue to the mystery of the origin of the flights which reach the North African coast.

May I, therefore, ask any interested person in any part of the world to publish—or to send to me—notes on the seasonal abundance of *Vanessa cardui* in his district, and particularly on any sudden appearances or disappearances of large numbers, and in general any notes or observations relating to the migration of this or any other insect.

Records of actual migrations should include the locality, date, species, approximate numbers, sexes (if possible), direction of the flight and of the wind, and any other notes on the meteorological or biological conditions. If, in addition, specimens actually caught on migration could be sent to me for examination and dissection, I should be very much obliged.

All original notes and observations sent direct to me will be published, as in the past, with full acknowledgments if of sufficient interest.

C. B. WILLIAMS.

(Acting Chief Entomologist.)

Ministry of Agriculture,  
Cairo, Egypt,  
January 14.

### The Spectrum of Potassium excited during its Spontaneous Combination with Chlorine.

THE spectrum of ionised potassium has been studied by many scientists by exciting the vapour with the condensed spark, electrodeless ring discharge, and electronic impacts. I have been recently studying the spectrum emitted by potassium burning in chlorine at normal pressure *spontaneously*, and have obtained the following interesting results.

The photographs taken with the quartz spectrograph show a very strong emission band in the red extending from about 7200 to 6150, corresponding to the emission and absorption bands obtained by McLennan and Ainslie in the fluorescence and absorption spectra respectively of dense potassium vapour. Besides this, many arc lines of moderate intensity and the following *enhanced lines* are seen:

4466, 4388, 4307, 4220 and 4115.

As the slit was kept fairly broad, some of the wavelengths given are the mean values for lines very close to each other.

These results show that the *electron affinity* of the chlorine atom, together with the temperature attained by the potassium vapour as a result of the chemical reaction, must account for the excitation of the *enhanced lines* in the absence of any external electrical forces. I am following up the work in connexion with the remaining alkali metals. A

detailed account of the results obtained hitherto, along with an explanation of the processes involved in the emission of the enhanced spectrum, will be published shortly.

L. A. RAMDAS.

210 Bow-Bazar Street,  
Calcutta, India,  
February 19.

### Heterogeneous Catalysis.

IN connexion with prevailing notions on heterogeneous catalysis, the following remarks of Graham, written in 1868 (*Proc. Roy. Soc.*, 16, 422, 1868; "Chemical and Physical Researches," 1876, p. 286), would seem to be of interest. Referring to the adsorption of hydrogen by platinum, he says: "The hydrogen appears to be polarised, and to have its attraction for oxygen greatly heightened. I beg to offer the following representation of this phenomenon, with an apology for the purely speculative character of the explanation. The gaseous molecule of hydrogen being assumed to be an association of two atoms, a hydride of hydrogen, it would follow that it is the attraction of platinum for the negative or chlorylous atom of the hydrogen molecule which attaches the latter to the metal. The tendency, imperfectly satisfied, is to the formation of a hydride of platinum. The hydrogen molecule is accordingly polarised, *orienté*, with its positive or basylous side turned outwards, and having its affinity for oxygen greatly enlivened. It is true that the two atoms of a molecule of hydrogen are considered to be inseparable; but this may not be inconsistent with the replacement of such hydrogen atoms as are withdrawn, on combining with oxygen, by other hydrogen atoms from the adjoining molecules. It is only necessary to suppose that a pair of contiguous hydrogen molecules act together upon a single molecule of the external oxygen. They would form water, and still leave a pair of atoms, or a single molecule of hydrogen, attached to the platinum." (The formula of water is evidently considered to be HO.)

J. R. PARTINGTON.

East London College,  
University of London.

### Influence of Radiation on Ionisation Equilibrium.

IN a recent letter (*NATURE*, March 14, p. 377) Saha and Swe develop the theory of the stationary state of a medium traversed by radiation of a temperature different from that belonging to the medium. Their argument seems to follow thermodynamic lines; supposing this to be the case, it may be of interest to point out how the same results may be obtained starting from Einstein's classical paper on Planck's radiation law (*Phys. Zeit.*, 18, p. 121, 1917) and from Milne's extension to the photo-electric effect (*Phil. Mag.*, 47, p. 209). The principle of this alternative method, already well known (Milne in this way recently has derived a formula equivalent to formula (3) of Saha and Swe, in his investigation of the equilibrium of a Ca<sup>+</sup> chromosphere, *Mon. Not. R.A.S.* 85, p. 119), consists in formulating the conditions required for a stationary state by means of probability laws governing the elementary processes involved. These probability laws themselves have been derived from the consideration that in thermodynamic equilibrium the number of elementary processes in one direction ought to balance the number occurring in the opposite direction.

For example, consider a gas traversed by radiation of a different temperature. Milne's results allow us to compute the ratio of the number of photo-electric

ionisations to the number of electron-captures accompanied by emission of radiation, in terms of the relative concentration of neutral and ionised atoms. Requiring this ratio to be equal to unity furnishes a value for the degree of ionisation identical with formula (4) of Saha and Swe.

J. WOLTJER, JR.

Observatory, Leyden,  
March 23.

### Bushman Rock Figures.

THE comparisons made by Prof. Dart (*NATURE*, March 21, p. 425) between Bushman paintings and Asiatic figures will need much wider knowledge than we at present have on our side. The turn-over cap called "Phrygian" belonged to Phœnicians of Tyre and Sidon, and to men of Dabig between the Euphrates and Gulf of Alexandretta (see "Gates of Balawat"). It is seen about the Mediterranean now, and is much like the cap of the London draymen fifty years ago. The cap with the long tail is not only Babylonian, but is the typical head-dress of the Hittite and Syrian god Sutekh. Both of these forms may have a much wider spread, and the Bushman might have been figuring a liriipe hood of five centuries ago.

The Figure 13, quoted as Egyptian, is a man of Punt. The "figurno of an Egyptian courtier of the period of Thothmes III." I have handled. It is a well-known kind of moulded pottery figure, from Thebes, but more probably modern than ancient. There is, no doubt, a wide basis of African custom and culture below Egyptian civilisation, of which I have quoted dozens of examples, in *Ancient Egypt*, 1914, pp. 115, 159, and the indications are that these are due to a common basis, and not to importation from Egypt. General likenesses to Egyptian figures do not strike those who know them best; the women of Fig. 12 might be Somalis, but not Egyptians. Resemblances of names require an exhaustive inquiry as to possible meanings and origins among all the languages that may have intervened, before they can be accepted with caution. A name always means something; it is not a casual sound.

FLINDERS PETRIE.

5 Cannon Place,  
Hampstead, N.W.3.

### On the Resonance Radiation from Thallium Vapour.

RECENTLY we have shown that the absorption spectrum of non-luminous thallium vapour exhibits lines corresponding to the sharp and the diffuse series, and that  $1\pi_2$  is the ground orbit of the valence electron in the atom of this element. A further confirmation of this view is given by our latest experiments on resonance radiation. In these experiments the radiation emitted from the vapour in a lateral direction was examined when the vapour was illuminated with light obtained by using different colour-screens. It has been found that the vapour, subjected to radiation  $\lambda 5350$  ( $1\pi_1 - 1\sigma$ ), does not emit any radiation, while when illuminated by radiation  $\lambda 3775$  ( $1\pi_2 - 1\sigma$ ) it acquires the ability of emitting radiations  $\lambda 5350$  and  $3775$ , the fluorescent track in this latter case being of a beautiful green colour. These experiments, together with the experiments on absorption, strikingly confirm that  $1\pi_2$  is the normal state of the atom. Further experiments in this direction are in progress.

A. L. NARAYAN.

K. RANGADHAMA RAO.

Research Laboratories,  
Vizianagram.

## The Migrations of the Painted Lady Butterfly.

By C. B. WILLIAMS, Acting Chief Entomologist, Ministry of Agriculture, Egypt.

THE migrations of birds have been known for centuries, and have, particularly in recent years, been moderately well studied and understood. The migrations of fishes are also generally known, and within the last few years the remarkable journeys of the eel have been definitely determined. Most people know that locusts make huge migratory flights, invading countries in countless numbers and doing incalculable damage; but it is surprising how few are aware that such frail insects as butterflies make extended migratory flights, often in enormous numbers and over hundreds and even thousands of miles.

Scattered throughout literature there are references to nearly two hundred species of butterflies which have been seen in migratory flights. In most of these there

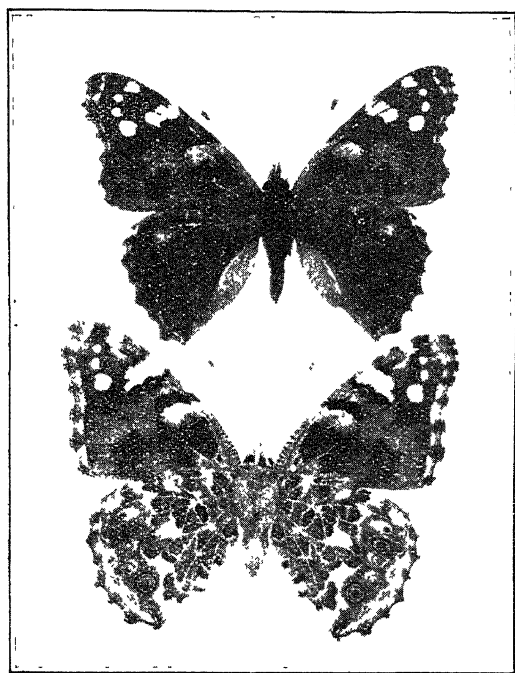


FIG. 1.—The Painted Lady or Thistle butterfly (*Pyrameis cardui*)

are unfortunately only one or two records for each species, and in only a very few cases do the records number more than a dozen. In two or three, however, we have sufficient evidence to get a general idea of the movement, and of these the most complete is that of the Painted Lady or Thistle butterfly, *Pyrameis cardui* (Fig. 1).

This butterfly, like many migrants, has a very wide range and is indeed known from every continent, and may be seen from the equatorial tropics to within a few degrees of the arctic circle. In Northern and Central Europe it is sometimes common, sometimes rare, and sometimes a summer will pass without a single specimen being seen. In England it is usually first seen at the end of May or beginning of June, and becomes again more common in August and September, but there is no evidence of an individual surviving the winter in any stage. The same seems to be true of all Europe

north of a line through the middle of France and South Germany or Switzerland.

Observation has shown that north of this line the country is dependent for its Painted Lady butterflies entirely on migrations from the south. In the late spring, isolated individuals or huge swarms of this butterfly set their faces more or less to the north or north-west and, in Western Europe, cross France and England, and in some years may reach so far as Iceland. Farther east, similar migrating bands may fly from Italy or the Balkan peninsula, and cross Switzerland, Austria, Czecho-Slovakia, and Germany, and invade Scandinavia. Still farther east, in Russia, it is probable that the same movement occurs, but the records are few and far between.

Studying the movement in the south of Europe, we find that the majority of the migrating insects do not originate here, but cross the Mediterranean from North Africa, apparently finding but little difficulty in the long sea passage. Still more recently, evidence has been accumulating that even the north coast of Africa and Palestine do not represent the origin of the insect, and it appears that they reach the coastal regions of Africa from the south. They have been recorded entering Algeria from the south; they have been seen crossing the Nile Valley near Cairo in thousands, coming from the south-eastern desert; they have been recorded as entering Palestine from the east in countless numbers for days on end; and finally comes a record of the same butterfly flying towards the west in Mesopotamia. They have been seen massed in great numbers, apparently resting during migration, in the Egyptian Desert near the Sudan border; but south of the desert belt, there is no record except a doubtful hint from Nigeria.

The present state of our knowledge of their movements in Europe, North Africa, and Asia Minor can therefore be summarised as follows (see also Fig. 2):

From somewhere in, or south of, or south-east of the long line of desert stretching across North Africa and Asia Minor, the butterflies begin their north and north-westerly movement in the early spring and arrive at the southern shores of the Mediterranean usually about April. From Palestine they appear to fly through Syria and Turkey to the Balkan States, and from Egypt, Tripoli, and Algeria they cross the Mediterranean, arriving in southern Europe usually early in May. They pass on, probably leaving behind stragglers all the time, and arrive on the level of the southern shores of England at the end of May or beginning of June, reach the northern part of Scotland about the middle of June, and have been recorded in Iceland in July.

The dates given are those of the first main drift, but the movement appears to continue for many weeks or even months at irregular intervals. Thus the butterflies have been seen crossing the Mediterranean north of Egypt so late as July, and in some years they appear to reach England from the Continent so late as September. These presumably are the progeny of later broods than the first movement. Apparently there is a general tendency for all butterflies over the whole

area to drift to the north-west during a large part of the year.

In other parts of the world there are also migrations, but the records are at present too few to be capable of discussion. They fly into California from the south in the spring at irregular intervals and have also been seen migrating in Florida. It is, however, only in Europe, North Africa, and Asia Minor that we can bind together the evidence into the semblance of a whole. It is curious to note that in Ceylon, where migrations of many species of butterflies occur on a very large scale, one observer notes that *P. cardui*, although not uncommon, has not been noticed as entering into any of the flights.

As the migrations of birds are better understood than those of any other animal, it will be interesting to draw

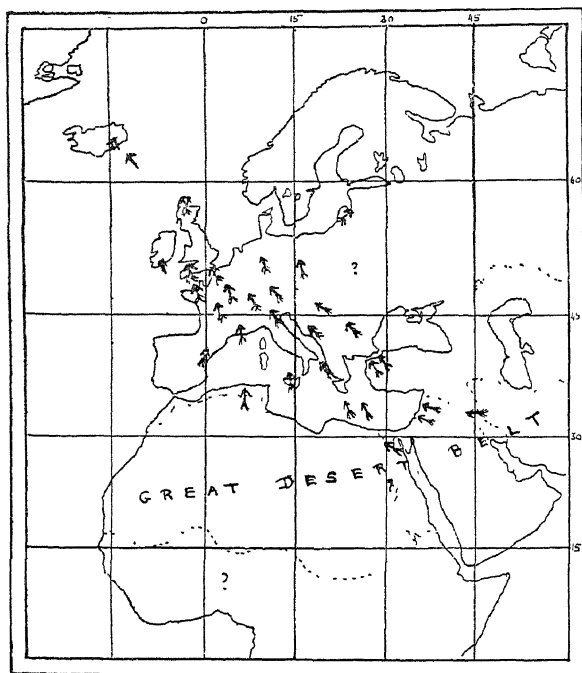


FIG. 2.—Sketch map indicating the known migrations of the Painted Lady butterfly.

a comparison and see to what extent the migrations of the Painted Lady butterfly resemble them.

In the first place, we have the remarkable fact that in the butterfly there is practically no evidence of any return from north to south in the autumn. So far as we can see, all those butterflies which fly to the north of the area in which they can breed throughout the year are lost completely to the species, as either they or their offspring perish during the winter. The butterfly does not seem to have developed the ability to hibernate in any stage; unless it can breed continuously it cannot survive. The statement seems so remarkable that some investigators believe that there is a return flight, but that it is performed individually and not in mass, and so escapes notice. While this may be so, it is at present unsupported by any direct evidence and must be classed as an hypothesis, as opposed to the known facts of the northward movement in the spring. One cannot help referring here to the remarkable contrast which is found in the case of the

Monarch butterfly (*Anosia plexippus*) in North America. Here the southward autumn flight is known from dozens of observations, while the direct evidence for the northward flight in the spring is extremely scanty, although from the complete absence of any record of hibernation in the Northern United States and Canada, we presume that such a return flight must occur.

The possibility must also not be overlooked that considerable flights may take place at night. This may seem to be a rather unexpected statement to be applied to butterflies, but it is actually supported by direct observation and capture of Painted Lady butterflies at night at light-ships and on boats at sea. The same butterflies have also been seen flying to the north off the coast of Egypt between three and four in the afternoon, and to reach land in this direction they must fly all night or rest on the sea.

In the case of the Painted Lady, it follows that even if there is a return flight, it is in a later generation. No individual butterfly ever performs the same journey twice, even in opposite directions, thus differing from most birds, which make the journey twice a year for several years. This eliminates any possibility of memory being a factor in the determination of the route.

The next difference between the migration of the butterfly and most birds is that it is only a part of the butterfly population which migrates, while many stay behind to continue breeding in the countries where they hatched out. If it is really true that there is no return flight, this of course would be absolutely necessary, as otherwise the species would gradually move northwards and become exterminated.

Next we have the fact that while the migrants which reach England, for example, lay eggs and produce offspring there, those that have stayed behind in South Europe or North Africa are also breeding. In contrast to what is usually found in birds, breeding takes place throughout the whole range of the migration.

This raises the question as to whether it is the same individuals that perform the whole flight from Africa or Mesopotamia to Northern Europe, or whether the first migrants stop to lay eggs on the way and their offspring continue the flight later. The evidence at present indicates that the same individuals can, and in favourable years probably do, complete the whole flight, but that their progeny may also form a later migration, starting from where the eggs were laid by the original migrants, or may continue the migration alone if for any reason that of the previous generation has been brought to an end.

This in turn raises another question. How is it that the butterflies have time to perform their long journeys, and, having hatched from a pupa in Africa, can wait to lay their eggs in England? The answer to this is still obscure, except that we know that *P. cardui* usually hatches out from the chrysalis with the generative organs completely undeveloped, but with a very large reserve fat-body. Apparently the migration generally takes place before the genital organs are functional (thus resembling the locusts); but this is not an absolute rule, as butterflies have been known to lay eggs while apparently on migration. When we know what determines the original development of the fat-body at the expense of the ovaries, and what later circumstances cause the ovaries to develop at the

expense of the fat-body, we shall be nearer the solution of one of the problems of migration.

Finally, as the life of the butterfly is not dependent on migration, we get another important difference from birds in the great irregularity of the occurrence and extent of the movement. Sometimes, as in 1879, Western Europe is invaded by countless millions, while in other years the migration is at a minimum and scarcely a single individual reaches the British shores. This irregularity of flight is probably an indication of varying conditions in the countries of origin of the swarms, but as we are not yet certain where these are or if they are always the same, it is idle to speculate as to what are the conditions that determine the start of the flight. Once the migration is in progress, what little evidence we have indicates that the direction is influenced, but not entirely determined, by the wind. The butterflies have a tendency to fly into the wind rather than with it, and there are one or two records, from localities with a daily change in wind direction due to land and sea breeze, of a corresponding daily change in the direction of the flight.

This tendency to fly more or less into the wind would of itself partly account for the general trend of the migration to the north and north-west, as in the spring there are prevalent northerly winds over Southern Europe, the Mediterranean, and North Africa (see Fig. 3). However, one feels that this alone is not the explanation of the main trend of the flight, and further study and many more records are necessary before it will be possible even to guess at the real cause.

We are similarly in ignorance as to what are the conditions which cause the insects to cease migrating—

if it is fatigue, low temperature, food, or the development of the sex organs and sex instinct, and if the latter, the problem is only put one stage further back to what is the cause of this change.

The final question, which is with so many the first to be asked, is: Why do the insects migrate?

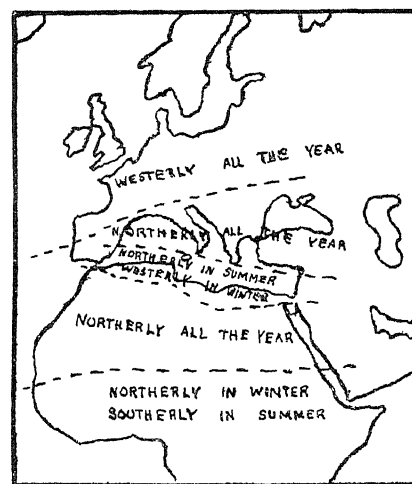


FIG. 3.—Prevailing winds in Europe and North Africa. From Kendrew's, "Climate of the Continents."

This is best perhaps at present left entirely alone. Whether, as some hold, a habit is explained when some advantage has been shown to accrue from it to the species, or whether, as I insist, there must be an immediate mechanistic cause for the migration of each individual, is a question the discussion of which would be out of place in the present article.

### Further Evidence regarding the Correlation between Solar Activity and Atmospheric Electricity.<sup>1</sup>

By Dr. LOUIS A. BAUER,

Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D.C., U.S.A.

THE geophysical element which has thus far shown the most marked correlation between manifestations of solar activity, as, for example, sunspottedness and prominences, is some measure of activity of the earth's magnetism. The range of the magnetic diurnal variation, as shown by observations extending over nearly a century, is known to pass through a definite fluctuation to the extent of 50 per cent., or more, during a sunspot cycle. The synchronism between the solar curve and the magnetic curve is not exact, however, the times of maxima of the two curves differing not infrequently by one year or more. Thus, at the Kew Observatory the absolute daily range of the magnetic declination during the period 1858-1900, or approximately 4 sunspot cycles, passed through a maximum value, three times out of the four cases, one year *in advance* of the sunspot maximum. During the recent sunspot cycle (1913-1923) the maximum magnetic activity showed a lag of two years with reference to the solar curve. In 1893, when sunspottedness was a maximum, the earth's magnetic activity, after having

been increasing for several years previous, was quite markedly lessened, and then rose to a maximum value in 1894.

Attention may also be directed to the fact that no index of the sun's activity, as given thus far by solar observations, is apparently a complete measure of the radiations or emanations which are responsible for the magnetic phenomena just described. Nor do the solar measures in themselves, or for that matter the magnetic measures, give us a definite indication of the *sign* of the electrically charged particles which may be shot out by the sun during periods of intense activity.

The desirability is thus seen of finding some other geophysical element which may be affected in such a manner by solar changes as to supplement effectively the knowledge gained from magnetic effects and polar lights. That element may be atmospheric electricity; some results concerning the correlation of this element with solar activity were presented before these societies<sup>2</sup> a year ago. The present communication is based on atmospheric-electric data accumulated during the past 7 sunspot cycles. Manifestly, it will not be possible here to attempt more than a summary of the entire

<sup>1</sup> Presented before the joint meeting of the American Physical Society, the American Association of Economic Geologists, the American Society of Civil Engineers (Physics) and D (Astronomy), December 30, 1924.

<sup>2</sup> See footnote 1.

investigation; those interested may be referred to the fuller publication.<sup>3</sup> Since atmospheric electricity is so continuously subject to much greater fluctuations of all kinds, natural and artificial, it will be appreciated that the tracing of a definite connexion with solar activity is much more difficult than in terrestrial magnetism, and, accordingly, an allowance must be made in the critical examination of the results. *So far as possible, only data derived from so-called electrically undisturbed days, i.e. days of no negative potential and no pronounced disturbances, have been utilised.*

#### ATMOSPHERIC POTENTIAL GRADIENT AND VARIATIONS.

In Table I.,  $s$  represents the percentage change in the atmospheric element corresponding to a change of 1 in the Wolf-Wolfer observed sunspot numbers, and  $S_m$  the mean sunspottedness of a complete cycle beginning with the year of minimum.

Table I. summarises the average values of  $s$ , expressed in percentages of the respective electric quantity, for each of the 7 sunspot cycles beginning with 1843, derived from the observed values of the potential gradient,  $P$ , and some measure of its diurnal and annual variations.<sup>4</sup> The stations for which sufficiently long series are at present available for the various cycles are as follows: Brussels for Nos. 1, 2, and 3; St. Louis, Missouri, for portions of Nos. 2 and 3; Greenwich for No. 4; Perpignan, Lyons, Kew, and Greenwich for No. 5; Kew, Greenwich, Perpignan, and Kremsmünster for No. 6; and Ebro (Spain), Eskdalemuir, and Kew for No. 7. An attempt has been made in the

TABLE I.—VALUES OF SUNSPOT COEFFICIENT,  $s$ , FOR ATMOSPHERIC ELECTRICITY, 1843–1893.

No.	Sunspot Cycle.	$S_m$ .	$s$ (per Cent.).	$w$ .
1	1843–1855	53.7	-0.70	0.5
2	1856–1866	49.6	+0.53	1.0
3	1867–1877	56.6	+0.22	1.0
4	1878–1888	34.6	+0.09	0.5
5	1889–1900	38.8	-0.24	1.5
6	1901–1912	31.1	+0.49	2.5
7	1913–1923	40.6	+0.24	3.0
Mean, Nos. 2, 3, 4, 6, 7		.	+0.34	8.0
Mean, Nos. 1 and 5		.	-0.35	2.0

last column to give some idea of the weight,  $w$ , to be attached to the tabulated  $s$ , according to the character of the available observations and number of stations utilised. Nos. 1 and 4 get the lowest weight (0.5), as they each depend on one station alone, no trustworthy observations at other stations for the corresponding period being at present available. No. 7, on the other hand, is given the largest weight (3), as it depends upon the most modern observations at three distant observatories; No. 6 ranks next in reliability. Though No. 5 depends on the data from several observatories, it is given a weight of but 1.5, as during the period covered the observations are all relative ones, the method of reduction to infinite plane not having as yet been introduced.

It will be observed that for five of the seven cycles the

sign of  $s$  is plus, which means that increasing potential gradient and diurnal and annual ranges corresponded with increasing sunspottedness, the average value of  $s$  being +0.34. For two of the seven cycles, namely, Nos. 1 and 5, the sign of  $s$  is negative, implying that increased potential gradient and ranges corresponded with decreasing sunspottedness, the average value of  $s$  being -0.35.

He who wishes to regard the two cases (Nos. 1 and 5) as contradictions of a definite correlation between atmospheric electricity and solar activity, may take the algebraic weighted mean of all values of  $s$  for the 7 cycles and obtain +0.20, which corresponds approximately to the value for the period (No. 7) of most trustworthy observations. However, I am inclined to advise leaving open the possibility of a reversed relationship, especially as the indications afforded by No. 5 are of a character not lightly to be dismissed. For example, the most striking part of the reversal occurred during the year 1893, when, as has already been remarked, there was also a notable depression in the earth's magnetic activity, in spite of its being the year of sunspot maximum;<sup>5</sup> this is the first definite correlation between disturbances in atmospheric electricity and terrestrial magnetism.

Comparing the values of  $s$  for the past two sunspot cycles, it will be observed from Table I. that, while they are both plus, the value for the cycle (No. 7) of more intense solar activity, as indicated by the mean sunspottedness,  $S_m$ , was only about one-half of that for the preceding cycle (No. 6). The same fact is found to apply to the values of  $s$  derived from two different measures of the earth's magnetic activity obtained independently by Dr. Bartels, of the Potsdam Observatory, and myself. The ratio of  $s$  (No. 6 : No. 7) is 2.0 for atmospheric electricity and 1.7 for terrestrial magnetism.<sup>6</sup> Even the variation during the year of  $s$  follows essentially the same law for both geophysical phenomena. Thus the ratio of  $s$  (October to March: April to September), for the period 1911–1921, was found to be 2.4 for atmospheric electricity and 1.7 for terrestrial magnetism. If a definite correlation is to be ascribed between solar activity and terrestrial magnetism, the facts just cited point to the conclusion that there is likewise a definite correlation between solar activity and atmospheric electricity.

Fig. 1 shows the high degree of correlation between solar activity and atmospheric potential gradient and its diurnal and annual ranges for the two sunspot cycles, 1901–1923, during which the atmospheric-electric data are of highest reliability. For the first cycle (1901–1912) we have available electric data at Kew, Greenwich, and Perpignan (France). For the second cycle (1913–1923) the data were obtained from the observatories at Kew, Eskdalemuir (Scotland), and Ebro (Spain). I desire here to acknowledge my indebtedness for latest data at these observatories to the very cordial co-operation in this research given by the respective directors.

While in the fuller publication the data from each observatory have been treated independently and

<sup>3</sup> See Fig. 2, *Terr. Mag.*, vol. 29, p. 31.

<sup>3</sup> *Terr. Mag. and Atmos. Elec.*, vol. 29 (1924), pp. 23–32 and 161–186.

<sup>4</sup> Table I. was derived from the values of  $s$  given *in extenso* in the author's Table 7, p. 171, *Terr. Mag.*, vol. 29, p. 171.

<sup>6</sup> While  $s$  for cycle No. 7 was only about one-half of that for No. 6, the total electrical output during each cycle may have been about the same. Thus if  $R$  is the range or difference in sunspot number between minimum and maximum, then we have for No. 7,  $R_s = 102 \times 0.24 = 24$ , and for No. 6,  $R_s = 61 \times 0.49 = 30$ .

without the use of any smoothing process, it was thought desirable in the graphs, Nos. 3, 4, and 5 of Fig. 1, to group them together as indicated and take smoothed means according to the well-known formula  $(a+2b+c)/4$ . With the aid of overlapping data for about two years, a preliminary attempt was made to refer the mean results for the two cycles to the same base line; a more accurate reduction will be possible later. Curve 5 is a combination of the results shown

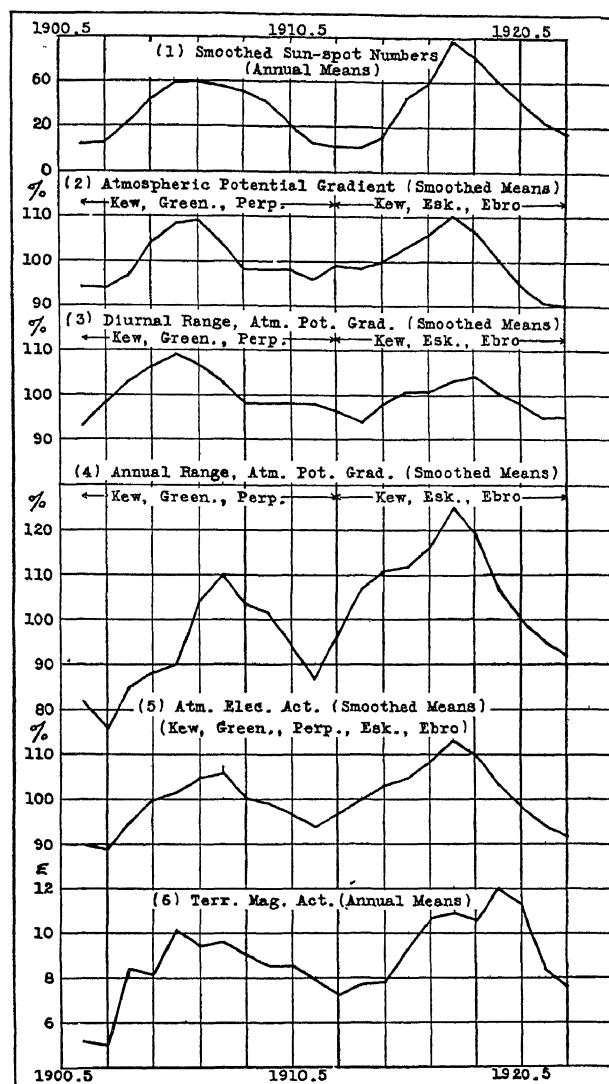


FIG. 1.—Showing degree of correlation between solar activity, atmospheric electricity, and terrestrial magnetism for the two sunspot cycles 1902-1923. (Dependent on atmospheric-electric data at Kew, Greenwich, Perpignan, Eskdalemuir, and Ebro, and on magnetic data at Potsdam, 1900-1905, and at Cheltenham, Maryland, 1905-1923.)

separately in Curves 2, 3, and 4. The smoothed sunspot numbers are those of Wolf and Wolfer with extensions according to latest data kindly supplied to me by Dr. Wolfer. Curve No. 6 of the measure of the earth's magnetic activity ( $\epsilon HR$ ) has been derived by me with the aid of the absolute diurnal ranges ( $R$ ) of the horizontal intensity ( $H$ ) at the Potsdam Magnetic Observatory, 1900-1905, and at the Cheltenham Magnetic Observatory, Maryland, from 1905-1923; the data at the two observatories were reduced to the same basis

and expressed in terms of the unit  $\epsilon$ . For the most recent values of  $R$  at the Cheltenham Observatory, I am indebted to the Director of the United States Coast and Geodetic Survey. In the case of Curve No. 6 no smoothing was attempted, in order to obtain some idea how satisfactorily a measure of terrestrial magnetic activity might be obtained from one observatory alone, in view of the smaller effect of local disturbing influences in terrestrial magnetism than is the case for atmospheric electricity; however, since the atmospheric-electric data pertain to the electrically undisturbed days, only the magnetic ranges from the ten least disturbed days per month were used.

From Fig. 1 the following conclusions may be drawn for the period 1901-1923: (a) The atmospheric potential gradient and its diurnal and annual ranges show a high degree of correlation with the sunspot curve, increasing atmospheric-electric quantity in each case corresponding with increasing sunspottedness for both cycles; (b) the combined measure of activity as obtained from observations of the atmospheric potential gradient and its diurnal and annual variations at several stations may show as high a degree of correlation with sunspottedness as measures of terrestrial magnetic activity; (c) the annual means of the atmospheric potential gradient, of its diurnal range, and of its annual range follow closely parallel courses from year to year. (Conclusion (c) has been found to hold generally for the various cycles investigated.)

Table II. will give some idea of the general agreement in the values of  $s$ , as derived separately from the observed values of the potential gradient, the diurnal variations, and annual variation at the three observatories. Eskdalemuir, Kew, and Ebro, for the region from Scotland to Spain and for the period of most trustworthy data, 1911-1921. The values of the correlation coefficient,  $r$ , are also given for each observatory; it will be seen that, for the potential gradient,  $r$  varies from 0.76 to 0.95, according to the location of the observatory, the mean value being 0.85. The mean value of  $r$  is lowest for the annual variation, as this quantity cannot be determined entirely satisfactorily from single years of observation. The mean value of  $s$ , it will be seen, is practically the same for each atmospheric-electric quantity.

TABLE II.—COMPARISON OF VALUES OF SUNSPOT COEFFICIENT,  $s$ , FOR VARIOUS STATIONS AND ATMOSPHERIC-ELECTRIC QUANTITIES, 1911-1921. ( $s$  is expressed in Percentages of Mean Values of Atmospheric-Electric Quantity.)

No.	Observatory.	Pot. Grad.		Diur. Var'n.		Ann. Var'n.	
		$s$	$r$	$s$	$r$	$s$	$r$
1	Eskdalemuir .	+0.19	0.85	+0.20	0.53	+0.44	0.65
2	Kew. . .	+0.20	0.76	+0.17	0.58	+0.19	0.30
3	Ebro . .	+0.31	0.95	+0.33	0.78	+0.23	0.32
4	Means .	+0.23	0.85	+0.23	0.63	+0.29	0.42

#### VERTICAL CONDUCTION CURRENT AND ELECTRIC CONDUCTIVITY.

According to observations at Kew (1911-1921) and Ebro (1914-1923), the vertical conduction current of atmospheric electricity during the past sunspot cycle apparently increased with increasing sunspottedness,

at the average rate of 0.32 per cent. for a change of 1 in the sunspot number. As this is about the same average rate of change shown by the potential-gradient observations at the same two observatories, the present indications are that the average rate of change for several stations of the atmospheric-electric conductivity with sunspottedness, if not zero, is small. The continuous observations of negative electric conductivity at the Potsdam Observatory likewise indicate but little change with changing solar activity. (Since this paper was prepared it has been found, by a method<sup>7</sup> which minimises the effect of uncontrolled changes in the factor to reduce potential gradients to volts per metre over level ground, that the average value of  $s$  for the Potsdam observations from 1913-1923 was +0.27 per cent. of the mean value of the potential gradient, *i.e.* the potential gradient increased, on the average, with increasing sunspot activity. Accordingly, the vertical conduction current at Potsdam also increased during 1913-1923 at the average rate of about 0.27 per cent. for an increase of 1 in the sunspot number.)

#### ATMOSPHERIC ELECTRICITY AND TERRESTRIAL MAGNETISM.

The foregoing results indicate a close correspondence between such changes in atmospheric electricity and terrestrial magnetism as may be dependent upon the state of the sun's activity from cycle to cycle. However, the close correspondence between the two different geophysical phenomena also holds in other respects. For example, the so-called "earth-effect" on sunspottedness during circumminimum years, the diurnal range of the atmospheric potential gradient, the diurnal range of the potential gradient of earth currents, the aurora borealis frequency for latitudes 51° to 58° north, and terrestrial magnetic activity all pass through a double periodicity during the year; the maxima and minima occur near the equinoctial and solstitial months respectively. Furthermore, the retardation of the second maximum from September to October is common to all phenomena. For further explanation, reference must be made to the fuller publication.<sup>8</sup>

*It would appear that terrestrial magnetism and fine weather atmospheric electricity are more closely associated than has heretofore been thought to be the case.* Besides

<sup>7</sup> See *Terr. Mag.*, vol. 29 (1924), p. 181.

<sup>8</sup> *Terr. Mag.*, vol. 29 (1924), pp. 175-179.

being subject to diurnal change, they both show similar fluctuations from year to year and from month to month. Whether atmospheric electricity, like terrestrial magnetism, is subject to a still longer cycle of changes than that of the sunspot cycle, seems not unlikely, and is the subject of further inquiry.

In a notable respect the changes of atmospheric electricity differ from those of terrestrial magnetism, namely, as regards relative magnitude. The periodic variations of the earth's magnetic elements are usually but fractions of 1 per cent. of the respective element, whereas in atmospheric electricity the diurnal and annual ranges, even for undisturbed conditions, may be of the same order of magnitude as the normal potential gradient itself. If such large percentage changes as 100, for example, are likely to occur in the potential gradient during the day and the year, it should not be surprising if there is, on the average, a 30 per cent. change between the years of minimum and maximum sunspottedness.

#### IS THE SUNSPOT INFLUENCE DIRECT OR INDIRECT?

While it may appear reasonable that atmospheric electricity does vary with solar activity, it is not possible to decide from *a priori* considerations whether the potential gradient ought to be high or low for maximum sunspottedness, as this depends on the *modus operandi* of the cause, the average sign of the electrically charged particles shot out from the sun, and whether the action is a direct or an indirect one. These are questions that must be reserved for future investigation. So much interest has now been aroused in the subject that we may confidently look forward to a more careful control in future of atmospheric-electric measurements than has at times been the case, and to a wider distribution of first-class observing stations.

In conclusion, it will be of interest to refer to the fact that while the present investigation has had to be based almost entirely on the atmospheric-electric data at observatories in western Europe, the final values of the potential gradients observed aboard the *Carnegie*, in all oceans, show that the mean value of the potential gradient for 1917, the year of sunspot maximum, was about 20 per cent. greater than the mean value in 1921, near the year, 1923, of sunspot minimum. This result corresponds well with the average corresponding change at the western European observatories.

### Obituary.

PROF. A. DENDY, F.R.S.

PROF. ARTHUR DENDY, whose death occurred on March 24, in King's College Hospital, at the age of sixty years, was educated at the Manchester Grammar School. On leaving school he proceeded to the Owens College, where he became one of a small band of distinguished zoologists trained by the late Prof. A. Milnes Marshall. He was the first of the students of the old Victoria University to gain a place in the honours school of zoology. Soon after he took his degree in 1885, he went to the Biological Station at Millport, and as a result of the work he did there he published his first two papers, one on a twelve-armed

specimen of *Antedon* and the other on the regeneration of the visceral mass of the same crinoid.

Although Dendy never lost his interest in the group of Echinodermata, it was for his wide knowledge and brilliant researches on sponges that he was destined to become a world-wide authority. He was called to London as an assistant in the British Museum (Natural History), and undertook to complete for publication the memoir on the monaxonid sponges of the *Challenger* expedition, which had been left unfinished owing to the serious illness of Mr. Stuart Ridley. He set to work with his characteristic energy and skill, and this "highly satisfactory" memoir was published in 1887.

In the following year Dendy was appointed lecturer in zoology in the University of Melbourne, a post he held until 1894, when he was promoted to the professorship in the same subject in the Canterbury College of New Zealand.

In the rich and extremely interesting fauna of Australasia, Dendy found full scope for his brilliant abilities in zoological research, and he published in rapid succession a long series of papers on the anatomy and development of some of the most interesting animals of that region. Apart from some excellent papers on sponges, he wrote on land planarians, on the land nemertine (*Geonemertes*), on the remarkable polyzoan *Cryptozoon*, on *Holothurians*, and on the *Collembola*. His valuable papers on the oviparous species of *Peripatus* greatly enriched our knowledge of this extremely interesting and archaic arthropod, and his study of the pineal eyes of the New Zealand lamprey *Geotria* threw important light on the history of these remarkable vestigial structures previously discovered in *Sphenodon* by his friend—also an old Owensian—Sir Walter Baldwin Spencer. On reaching New Zealand he lost no time in going in search of *Sphenodon* itself, and, on finding that there was serious danger that the enterprise of collectors would lead to its early extinction, he made urgent and successful appeals to the Government to pass measures for its protection. He was the first to write an account of the development of this reptile, and to record many important features of its anatomy and natural history.

In 1902 Dendy came back to England on a visit, and was given the hospitality of the Zoological Department of his old University in Manchester to enable him to pursue some investigations on which he was engaged. Here he completed his description of the aberrant floating hydroid *Pelagohydra* and examined sections through the brain of the *Ammocoetes* larva. In studying the anatomy of the *Geotria* in New Zealand, he had discovered a pair of ciliated grooves lying beneath the posterior commissure of the brain, and he found these grooves to be even better developed in the brain of the young *Petromyzon*. On these researches he published an interesting paper, which appeared in the *Proceedings of the Royal Society* in 1902. His studies on these brains led him to the investigation of another structure in the nervous system of vertebrates, namely, Reissner's fibre. On this subject, also, he made a very important communication to the *Royal Society* in 1910.

While he was in England on this visit, Dendy heard of the vacancy in the chair of zoology at Cape Town. He applied for the post and was appointed. But he remained in South Africa only two years, as he received the appointment to the professorship in King's College, London, in 1905, vacated by the retirement of the late Prof. F. J. Bell. He held this chair until his death. He was elected a fellow of the *Royal Society* in 1908.

In London Dendy carried on his teaching and researches with increasing energy and success, and under his guidance King's College soon became recognised as an active centre of research in his subject. He put together some of his teaching notes in the form of a book entitled "*Outlines of Evolutionary Biology*," which was published in 1912 and has already reached a third edition, and he also wrote an interesting little

book entitled "*The Biological Foundations of Society*," which was published in 1924.

The last important work he wrote was the memoir on the Antarctic sponges reviewed in *NATURE* of March 7, p. 330, but a preliminary note published in these columns on February 7 showed that he had in hand a paper in which he was prepared to maintain the rather startling proposition that the spicules of siliceous sponges are formed by the skeleton-forming cells enveloping migratory symbiotic organisms resembling micrococci. Many of his friends looked forward with much interest to the fulfilment of his promise made last December to maintain this thesis at the next meeting of the British Association.

Dendy was a man with a very striking and impressive personality, a fine speaker, and a clear and sympathetic teacher. His father was a well-known Unitarian minister. One of his sisters, Miss Mary Dendy, is widely known for her philanthropic work, particularly in connexion with the care and education of feeble-minded children. Another sister married Dr. Bernard Bosanquet, and is herself a well-known writer.

S. J. H.

WITH the sudden and untimely death of Prof. Dendy, we have lost the only man in England with a catholic knowledge of sponges, and probably the leading authority of the two or three in the world who could be classed with him. He was a biologist with wide scope of learning and research as well as a spongologist, but it is of his work on sponges only that I am competent to write.

A catalogue of Dendy's papers on sponges would be long. They begin in 1886, when he was twenty-two, with Ridley and Dendy's "Preliminary Report on the Monaxonida . . . *Challenger*"; they end with a letter, unseen by me as I write this (March 26), which appears in *NATURE* for March 28, and shall remain in these columns unanswered. Ridley and Dendy's classic *Challenger* monograph (1887) was written as to some five-sixths by Dendy, a wonderful piece of work for so young a man. Then came careful anatomical and histological studies of single species (*Q.J.M.S.*, 1888 *et seqq.*). Beside them the "Monograph of the Victorian Sponges . . . *Homocela*" (1891) described several important new forms, of some of which we have little added information—one is now recognised as of generic rank by the name *Dendya*, not conferred by its discoverer. But the contemporary importance of the "Monograph" was that it carried on Poléjaff's revolt (*Challenger* "*Calcarea*," 1883), and struck loose from Haeckel's "*Kalkschwämme*," and in this it was followed by "Observations . . . and Classification of the *Calcarea Heterocela*" (1893, *Q.J.M.S.*), which made a serious and valuable attempt at classification *de novo*.

It would be a long article which should follow Dendy from youth to maturity and from maturity to the admirable work of his last years; we may say briefly that Vosmaer's "Bibliography" to 1913 (in press) gives him thirty-five publications, mainly before 1898, and that his masterly "Reports" since 1913 on collections of sponges add up to 460 quarto pages of print. They are all good. As in other descriptive monographs, there is much which is only readable to the colleague whose interest has been aroused in the

organism described. But there is no slovenly work, and nothing written without purpose, responsibility, and accuracy.

Dendy was above all truthful in record. I have followed much of his work very closely in calcareous sponges, and I have never found the sign of anything described which I had reason to doubt had been seen. He was a beautiful draughtsman, and I have always considered that I could trust one of his drawings as if I had seen the specimen. Four or five years ago I questioned him as to certain details in his early illustrations (*a*) of the collar-cells of *Halichondria*, (*b*) of the pore-canals of *Leucosolenia stolonifer*. He showed me under the microscope the actual sections from which the drawings had been made, a third of a century earlier, and the fidelity was perfect.

Dendy's life's work as regards sponges was to accomplish a revised classification of the whole group and of their spicules. He was an evolutionist to the core, and believed in the evolutionary chain not only for all forms of sponges but also for all their spicules. His work, however, led him to the conclusion that it is impossible to consider the detailed form of spicules to be evolved for functional advantage to the sponge, and in the case of the two-disc spicule of *Latrunculia* he, in conjunction with Prof. J. W. Nicholson, gave a most important physical theory of the nodal position of the discs.

I have elsewhere expressed disagreement with his classification. But Dendy had investigated probably more forms of sponges than any one else has ever done, unless possibly Topsent, Hentschel, or Vosmaer. His works constitute a logical catalogue of their forms and of their spicules, illustrated almost entirely by himself with innumerable accurate drawings and accompanied by clear and careful description. He has made research on sponges easier for all who come after him; he has left order where there was much chaos.

Dendy enjoyed public discussion and hard hitting, given and received without disturbing private friendship. Veracity in record, swift work, accurate observation, clear description, untiring industry and enthusiasm for biological knowledge—these were his characters.

In ten years have died Minchin, Maas, Vosmaer, Dendy. The evening grows chilly.

GEO. P. BIDDER.

MR. THOMAS HUGH POWELL, who died in London on February 19, was a remarkable personality in the microscopical and photographic world. He devoted practically the whole of his life to the development and improvement of appliances in connexion with microscopes and photography, and, following in the footsteps of his father, Mr. Hugh Powell, was responsible for many progressive inventions. When Mr. Powell's father died in 1883, it was said of him in an obituary notice in the *Times* that he was the first optician in England to construct object glasses on Amici's "immersion" system. After making a considerable number of one-eighths, one-sixteenths, one-twenty-fifths, and one-fiftieths, he completed, with the assistance of his eldest son, who has just died, an object glass of this kind having a focal length of one-eightieth of an inch. The formula of the "homogeneous immersion" system was the subject of special attention on the part of Mr. Powell, sen., but failing health compelled him to rely on the efforts of

his son, by whom object glasses on this formula, having the highest apertures on record, were constructed. Mr. Powell was within a month of his ninety-third birthday at his death, having been born in March 1832. He was believed to be the oldest member, both in age and in length of membership, of the Royal Microscopical Society and the Quekett Microscopical Club, and displayed an active interest in his life-work to within a short time of his death.

WE much regret to record the death of Mr. Robert Standen, Senior Assistant-keeper in the Manchester Museum, who died on March 15, aged seventy-one years. He was born at Goosnargh, near Preston, and spent his whole life in Lancashire, forming one of the band of first-rate field naturalists who have done so much work on the fauna and flora of the north-west of England. He had wide knowledge and experience, and would have something of interest to say about most of the live things met with on a country walk, and to this he added a skilful museum technique and a scholar's knowledge of his special group—mollusca—on which he wrote many papers both on the British and, in conjunction with Dr. Cosmo Melvill, on foreign forms. In recent years he was active in promoting interest in neglected groups and quickly made himself an authority on wood-lice: here and everywhere he never grudged time and trouble spent on helping any one who asked for assistance. His services to natural knowledge were recognised by the M.Sc. degree which was conferred upon him by the University of Manchester in 1924.

THE issue of the *Physikalische Zeitschrift* for February 15 contains an obituary notice of Gustave Jaumann, professor of physics in the Technical School of Brünn, from the pen of his colleague Dr. E. Lohr. Jaumann was born at Karansebes in South Hungary on April 18, 1863, and was educated in Prague and Vienna. In 1885 he became assistant to Mach at the University of Prague, in 1893 professor of physics there, and in 1901 at Brünn, where he died suddenly on July 21, 1924. He published a number of experimental investigations on electric discharges and cathode rays, but is probably best known by his theoretical work, which is in great measure co-ordinated in his 1918 paper on the physics of continuous media.

THE editors of the *Journal of Genetics* inform us that they have received, with great regret, news that Mr. V. Issayev, of the University of Leningrad, has been killed in the Caucasus. The last number of that *Journal* contained a remarkable memoir by Mr. Issayev, giving the results of novel and curious experiments on grafting different species of *Hydra* together (noticed in *NATURE*, March 21, p. 438).

WE regret to announce the following deaths:

Mr. W. W. Rouse Ball, fellow and formerly tutor of Trinity College, Cambridge, on April 4, aged seventy-four.

Prof. Burt G. Wilder, professor of neurology and vertebrate zoology in Cornell University from 1867 until 1910 and afterwards emeritus professor, and president in 1885 of the American Neurological Association and in 1898 of the American Association of Anatomists, on January 21, aged eighty-three.

## Current Topics and Events.

A LETTER sent to us addressed from the Nanking Branch of the Science Society of China is of particular interest now that the China Indemnity (Application) Bill, having passed the Committee stage, is down for third reading in the House of Commons. It is satisfactory to learn from the writer, Mr. Co-Ching Chu, that this important Society is in full agreement with our editorials of August 30 and November 29 last, not only on the principles and the chief details of expenditure there enunciated, but also on the object underlying our proposals, namely, the promotion of mutual understanding and goodwill between England and China. At the same time our correspondent utters a word of warning to our legislators. Expenditure on purposes other than educational and cultural may, he says, help to prolong the political turmoil in China, and to increase the antagonism towards foreigners. Coming from a responsible Chinese, these are arresting words. It is, however, unfortunate that he credits the unfounded rumour that the change of personnel on the Advisory Committee indicates a reversal of policy, by turning from education to railways, and in particular to a line along the Yangtze Valley.

ALTHOUGH railway construction is not ruled out by the vague wording "educational or other" purposes which Mr. McNeill has persistently retained in the China Indemnity (Application) Bill, such usage has been expressly disclaimed by him in recent debates. He specifically declared to the Standing Committee that, while the main object of this Government, as of the last, is educational, the Government refuses to pledge itself even to education, if some other ameliorative object urgently presents itself. While such an attitude is understandable in normal circumstances, it is not merely unstatesmanlike but futile now when an anti-foreign feeling is gathering head in China, and the Chinese are accepting the views pressed by nationalistic agitators that the remitted moneys are all of the nature of returned loot. In any event, the sums remitted are so small when the size and the needs of China are considered that if distributed in dribbles, as seems contemplated, no appreciable result will ensue. Certain institutions will, of course, benefit, but so far as the goodwill behind our gift is masked by vagueness, our allocations, however carefully considered, will make no call on the goodwill of a responsive people, while the timid handling of co-operation, contrasting unfavourably with that of other remitting Powers, will do nothing to stem the tide that day by day runs more strongly against the foreigner and all his works.

A SMALL volume by Dr. Marie Stopes, entitled "The First Five Thousand," being the first report of the results achieved by the Birth Control Clinic established by Dr. Stopes and her husband at Marlborough Road, Holloway, has been published by Messrs. John Bale, Sons, and Danielsson, Ltd. That some form of birth-control is the only means of regulating the tendency of the population of Great Britain to increase be-

yond the limits of our food supply is a conclusion which has forced itself on more and more thinkers, both in the biological and economic spheres. But birth-control is a subject against which more emotional prejudice can be aroused, than against almost any other subject of discussion. In the volume before us Dr. Stopes gives a full, clear account of the foundation and organisation of the clinic, and of the care that is taken to prevent the knowledge imparted from being used for purely immoral purposes. The sound rule is adopted that full advice is given only to women who have already borne one child. Dr. Stopes is fully convinced (perhaps some of her critics think too fully convinced) that the method which she adopts is the only safe and innocuous one, but she certainly brings forward strong evidence in support of her contention, for out of 5000 cases she can only find evidence of 42 failures, whereas to judge from the figures which she gives, the percentages of *successes* when other methods have been employed has never risen above 25 per cent. Dr. Stopes would perhaps admit that the storm of criticism, of which she has been the target, has led her to perfect the means employed, so that these criticisms shall be deprived of their ground. After all, there is no getting away from the fact that the practice of birth-control is widely spread among the middle classes, and to deny the knowledge of the means to the poor, who need it far more than the middle-classes do, is a proceeding which no parliamentary language is strong enough adequately to criticise.

THE Chemistry Section at the British Empire Exhibition this year is again being organised by the Association of British Chemical Manufacturers. In a purely business exhibition, designed to bring buyers and sellers together, a chemical display necessarily consists of samples of products. This year's exhibit, however, will be designed mainly to interest the public and give the visitor some idea of the extraordinary part which chemistry plays in the national life. For example, instead of the individual dye-stuff makers each having their own display, there will be a large combined exhibit which will show, not only the immense variety of articles into which colour enters, but also what beautiful effects can be obtained by the use of dyestuffs made in Great Britain. The Scientific Section, which created so much interest last year, will also be remodelled. The public has now some idea of the position of Great Britain as a leader in scientific research. It is proposed, therefore, to show how strikingly connected are the various stages in manufacturing processes, from basic materials to the finished product. This subject will be treated by taking as a basis coal, salt, and food. From the consideration of, for example, the raw coal, the visitor will be taken through the various stages of distillation of coal, the products of such distillation, such as tar and ammonia, the treatment of tar, and the resulting intermediate products which lead up to the manufacture of dyestuffs. The production of benzol, of disinfectants, of fine chemicals, of medical products,

and the numerous other chemicals obtained from coal will also be illustrated. In this way it is hoped to demonstrate the importance of chemistry and chemical research in our daily life.

"CHEMISTRY IN THE SERVICE OF THE STATE" is the title of a brochure, published by the Department of Chemistry of the University of Wisconsin, which sets out clearly and concisely the importance of chemistry in industry and in private life. Unlike some recent propaganda, this publication is practically free from overstatements, and within its limits it may be said to constitute an exceedingly able presentation of the case; it indicates in plain language the relations of chemistry to agriculture, to medicine, and to some important industries, and outlines briefly a few of the urgent problems that await solution. The value of chemistry as a handmaid to other sciences appears to be well appreciated in Wisconsin, for we read that 89 per cent. of the 1386 university students who took chemistry in 1923 were specialising in other subjects. Perhaps the weakest section of the pamphlet is that concerning the cultural value of chemistry, but the weakness resides largely in the subject itself, for chemistry is essentially a material science, and culture connotes much more than a knowledge of the transformations of matter. The authors therefore do well to emphasise the value of chemistry as a field for the exercise of the scientific method, but the implication that ability acquired in this sphere is transferable to everyday life would be strenuously resisted by many modern psychologists. Further, the artist and the moralist would demur to the statement that the main business of life is to adapt ourselves to our environment. Does not the chemist himself seek to make his environment subservient to his own ends?

THE Ministry of Agriculture has recently issued a brochure of eight pages entitled "Wasps." Information is sought by numerous inquirers every season as to the species of wasp that happens to have attracted notice, while queen wasps are frequently mistaken by the uninitiated for the larger species or hornet. These difficulties should be got over by the present publication, since all the seven species of British social wasps are clearly described in non-technical language, while identification is further aided by the remarkably well-executed coloured figures of all the species. The letterpress includes a short account of the habits, nest-building, methods of destroying nests, etc., together with some cautiously worded observations on the food of wasps. The reader will gather from the facts brought forward that, although wasps may prey upon a certain number of noxious insects they are, on the whole, not to be regarded as beneficial. The recent innovation of issuing pamphlets of a fuller nature than the usual leaflets of the Ministry, and illustrated by coloured plates, is to be commended. Various insects of economic significance require this fuller method of treatment, and it is to be hoped that the practice will be extended. Brochures of a similar character on the frit fly, wireworm, certain fruit pests and other subjects would probably meet with a wide demand.

Characteristic damage to plants by pests is often made far more easily recognisable to the agriculturist and fruit-grower through the medium of accurate coloured illustrations than by detailed descriptions and black-and-white figures. The wasp pamphlet is priced at the low figure of 4d., post free, and can be obtained from the Ministry's Offices at 10 Whitehall Place, London, S.W.1.

THE output of mathematical research from the Masaryk University, founded in Brno in 1919, is already such as to show that an active school of post-graduate mathematics has been instituted there. A parcel of 46 recent memoirs, edited by M. Hostinský, and issued separately in Brno as "Publications de la Faculté des Sciences de l'Université Masaryk," contains research work, mainly on pure mathematics, carried out recently by some twenty authors in Czechoslovakia. Typical examples are Hostinský's "Notes sur l'équation de Fredholm," "Kolaček's "Les tremblements de terre Carpathiques sur le territoire de la République Tchèque," Kaucký's "Sur une équation singulière de Volterra de première espèce," Seifert's "Remarques sur une surface cubique à point uniplanaire," Bortivka's "Sur les racines imaginaires de l'équation  $\Gamma(z)=a$ ," and Lerch's "Études sur la théorie des résidus quadratiques suivant un module premier." Most of the memoirs are printed in Czech, and followed by a French translation or abstract. Nearly all of them show that the authors are familiar with the literature of their subjects. As a whole they prove how seriously scientific research is being pursued in a new university, despite the economic conditions of eastern Europe. If this rate of progress is maintained we foresee that the world of science will soon reckon the Masaryk University to be on a par with universities supported by greater wealth and with more age and tradition behind them.

THE question of the seat of the mechanism of aural analysis was brought strongly into notice some years ago by the publication of Sir Thomas Wrightson's "Analytical Mechanism of the Internal Ear." In that book, Wrightson, supported by Sir Arthur Keith, gave reasons for the view that the internal ear does not contain any analysing mechanism, that the individual nerve fibres have no characteristic individual function and act only in mutual support as transmitters of influence to a cerebral centre of analysis. On that view the ear misses the opportunity of analysis which Helmholtz regarded the basilar membrane as furnishing. Holders of it scarcely give sufficient weight to the knowledge and scientific judgment of Helmholtz when they conclude that the membrane cannot act as he considered it to do. A recent publication, "The Mechanism of the Cochlea," by Drs. Wilkinson and Gray, gives strong support to Helmholtz's view by means of scaled models. In "Some Questions of Phonetic Theory," chap. vi. (separately published), Dr. W. Perrett criticises adversely Wilkinson's and Gray's discussion. Unfortunately, the sarcastic style in which a large part is written is scarcely appropriate in a scientific discussion.

IN the annual address to the Asiatic Society of Bengal, delivered on February 4, the president, Sir Rabindra Nath Mookerjee, exhorts the members of the Society to renewed activity and appeals for the support of Princes and Zamindars as well as commercial magnates to enable the Society to continue and extend its work. The present position of the Society is one of considerable moment to those in Great Britain who are interested in those researches in India with which the Society concerns itself, and it may be hoped that the exhortations of the president will bear fruit. The address, which is a summary of the history and achievement of the Society since its inception in 1784, provides much material for reflection on the social and political changes which have taken place in that period in their relation to Indian studies. It is noted that whereas at one time research was largely, indeed almost entirely, in the hands of Indian Civil Servants, officials have now almost ceased to take any part in the Society's work, and there has been a great falling off in the interest shown by Europeans generally. The Society has great traditions, and European students now look to the natives of India to carry on these traditions worthily.

IN the issue of *Science* for February 20, Prof. Richard Hamer, of the University of Pittsburgh, Pa., enters a plea for naming the missing element of atomic number 43 before it is discovered; in view of the work of Bosanquet and Keeley (*Phil. Mag.*, 1924 (6), 145-147) and of others, he thinks that the discovery cannot be long delayed, and also that by taking time by the forelock in this manner, subsequent controversy, like that which followed the discovery of hafnium, will not arise. Prof. Hamer appeals to the scientific world to name the element "Moseleyum," in honour of the young British physicist who fell in Gallipoli, and to give it the symbol "Ms." In our view it would be a fitting tribute to the brilliant work of Moseley to perpetuate his name in some such way. Hitherto, no chemical element has been named after an individual (we exclude mercury, tantalum, thorium, and titanium for an obvious reason), and opinion may be divided on the advisability of making the innovation. It is, however, a mistake to be bound by precedent in such a matter, and the only objection we can foresee to the adoption of Prof. Hamer's suggestion is that the word is not particularly euphonious, and is rather suggestive of certain sepulchral monuments; but it might be argued that even this suggestiveness is not inappropriate, inasmuch as mausoleums are erected, as a rule, to the memory of the illustrious dead.

PROF. F. SODDY, professor of chemistry in the University of Oxford, has been elected a corresponding member of the Russian Academy of Sciences.

THE period of Summer Time in Great Britain will begin this year at 2 o'clock Greenwich mean time on the morning of Sunday, April 19. Summer Time in France and Belgium began on the night of Saturday-Sunday, April 4-5.

PROF. W. WIEN, professor of experimental physics in the University of Munich, will deliver the tenth Guthrie Lecture of the Physical Society of London on Friday, April 24, at the Imperial College of Science, South Kensington. The subject of the lecture will be "Recent Researches on Positive Rays."

AT the meeting of the Royal Geographical Society on Monday, April 6, the president announced that His Majesty the King has been pleased to approve the award of the Royal Medals of the Society as follows:—the Founder's Medal to Brig.-Gen. the Hon. C. G. Bruce for his life-long geographical work in the exploration of the Himalaya culminating in his leadership of the Mount Everest Expeditions of 1922 and 1924; the Patron's Medal to Mr. A. F. R. Wollaston for his explorations and journeys in Dutch New Guinea, Central Africa, and many other parts of the world. The Council has made the following awards:—the Murchison Grant to Mr. Eric Teichman for his travels in China and Tibet; the Back Grant to Capt. Bernier for his work in the Canadian Arctic; the Cuthbert Peek Grant to Mr. Michael Terry in support of his proposed journey across Northern Australia; and the Gill Memorial to Major R. E. Cheesman for his journey to the deserts of Jafura and Jabrin.

IN order to preserve the fauna of the Southern Ocean the Government of France has issued a decree constituting a national Antarctic reserve in certain territories belonging to France. According to *La Géographie* for January, the reserve includes all the Crozet Islands, St. Paul and Amsterdam Islands, and on Kerguelen certain islets on the north coast and parts of the south coast to a depth of 1000 metres from the land. Within these areas it is forbidden to hunt whales, seals, or sea-birds. No special means are proposed for enforcing these prohibitions, which must naturally depend on the good faith of the hunters who frequent these seas.

DURING two months following the Japanese earthquake of 1923, Mr. H. M. Hadley examined several hundred buildings in Tokyo and Yokohama that were damaged by the earthquake as well as several hundred others that escaped injury (*Bull. Seis. Soc. of America*, vol. 14, 1924, pp. 6-8). His general conclusion is that, whatever the material used—whether the buildings were steel-framed, of reinforced concrete, of brick or of wood—those that escaped were so framed and braced that they moved as a whole when their foundations were shaken. Of the large steel-framed buildings in Tokyo, those undamaged owed their immunity to the extensive use of reinforced concrete wall construction. A small amount of properly distributed wall construction at the corners and elsewhere was sufficient to protect buildings from the slightest damage. But, though earthquake-proof construction can be secured with any material, the safest and most economical results can be obtained "with structural steel or reinforced concrete, both embodying an adequate amount of reinforced concrete wall construction."

A REPORT on the meteorological service of Australia for the year 1922-1923 has been submitted to the Parliament of the Commonwealth by Mr. H. A. Hunt, the Commonwealth Meteorologist. The report deals with the Central Weather Bureau at Melbourne and with the Weather Bureaux at Sydney, Brisbane, Adelaide, Perth, and Hobart. At the Central Weather Bureau at Melbourne, reports are received daily from a large number of stations, embracing the adjacent islands, and from stations in New Zealand. By the aid of these reports, the South Pacific Islands are warned when cyclonic conditions are developing. The data are also used for the ordinary storm-warning service for the protection of the Queensland and New South Wales coasts and of shipping traversing the waters eastwards from Australia. Rainfall maps

showing the total rainfall for each month for several stations are published on the first day of the following month. Aviation forecasts are regularly issued, and the Aviation School at Point Cook is informed whenever easterly gales are expected; the latter seems an admirable precaution. Ocean forecasts and storm-warnings, in addition to being distributed to coast stations, are broadcasted to ships at sea. The prevailing conditions of the weather round the coast are also supplied to radio stations. A careful analysis is made of the forecasts; on the average of fourteen years, the official forecasts verified for the States and for the Commonwealth as a whole reaches 87 per cent. There are 484 climatological and 5912 rainfall stations distributed throughout the Commonwealth and the adjacent territories.

### Our Astronomical Column.

NEW COMETS.—Still another comet, 1925 c, has to be added to the list of discoveries. It was discovered by Mr. Orkisz in Russia on April 4, and was observed by Mr. Möller, at Copenhagen, on April 5<sup>d</sup> 2<sup>h</sup> 52.7<sup>m</sup> G.M.T. in R.A. 22<sup>h</sup> 26<sup>m</sup> 45.13<sup>s</sup>, N. Decl. 16° 37' 19". The motion in R.A. is small: that in declination is about 1° daily northward. The magnitude is 8. The comet is in Pegasus, and must be looked for in the east just before dawn.

Both Schain's and Reid's Comets were observed by Dr. Steavenson as follows:

Comet.	G.M.T.	R.A. 1925 0	Decl. 1925 0
Schain	Apr. 2 <sup>d</sup> 1 <sup>h</sup> 55.6 <sup>m</sup>	11 <sup>h</sup> 31 <sup>m</sup> 26.1 <sup>s</sup>	+ 2° 27' 37"
"	" 3 22 42.8	11 28 11.0	+ 2 35 49
Reid	" 2 1 6.4	13 21 47.7	- 22 22 49
"	" 4 0 40.9	13 19 32.7	- 22 53 54

The following orbit of Schain's Comet is by Dr. A. C. D. Crommelin. It is still subject to appreciable correction, but is much nearer the truth than Kobold's orbit, which made perihelion occur in November 1924.

T	1925 Nov. 2 58 G.M.T.
$\omega$	216° 35' 5"
$\Omega$	357 30.6 } 1925 0
$i$	146 6.9
$\log q$	0.59512.

The perihelion distance is the second greatest on record, being exceeded by that of the comet of 1729 alone.

EPHEMERIS FOR 0 <sup>h</sup> GREENWICH.					
	R.A.	N. Decl.	$\log r$ .	$\log \Delta$	
April 11	11 <sup>h</sup> 16 <sup>m</sup> 4 <sup>s</sup>	3° 6'	0.6351	0.5355	
" 19	11 3 24	3 36	0.6323	0.5438	
" 27	10 51 56	3 59	0.6296	0.5546	

The comet should be in sight for two years or more. It is at present not far from the orbit of Jupiter.

The following orbit of Reid's Comet is by Mr. Möller and Miss Vinter-Hansen, of Copenhagen Observatory. Almost identical elements were found by Mr. G. Merton.

T	1925 July 22.951 G.M.T.
$\omega$	244° 19.8'
$\Omega$	7 41.6 } 1925 0
$i$	30 14.8
$\log q$	0.29608.

EPHEMERIS FOR 0 <sup>h</sup> GREENWICH.					
	R.A.	S. Decl.	$\log r$ .	$\log \Delta$	
April 10	13 <sup>h</sup> 12 <sup>m</sup> 35 <sup>s</sup>	24° 25'	0.3693	0.1345	
" 14	13 7 26	23 25			
" 18	13 2 6	26 23	0.3601	0.1194	
" 22	12 56 39	27 19			
" 26	12 51 12	28 12	0.3513	0.1099	

The comet is fairly bright, with a distinct nucleus, but is too low down for convenient observation in England.

SPECTROSCOPIC PARALLAXES OF 520 STARS OF TYPES F TO M.—Mr. W. B. Rimmer in vol. 64 of the R.A.S. Memoirs gives a full discussion of the absolute magni-

tudes and parallaxes of 520 stars from observations at the Norman Lockyer Observatory, Sidmouth. The curves connecting strength of lines with absolute magnitude were deduced from (1) moving-cluster parallaxes, (2) parallactic motion, (3) trigonometrical data; the last fails for the distant stars of high luminosity.

Special attention was given to the exact spectral type of the stars, published results being revised in several cases. Comparison of results is made with those of the Dominion Observatory, Victoria, B.C., the agreement being satisfactory.

On the whole the new parallaxes slightly exceed the trigonometrical ones, but the mean difference is only about 0.002". The parallax of Polaris is given as 0.014", in good agreement with the value 0.016" obtained from the law connecting luminosity with period in Cepheids. That of Betelgeuse is also 0.014", which is near the mean of other determinations. For  $\alpha$  Centauri and 61 Cygni the values found were 0.770" and 0.300", but these are more a check on the graduation of the curves than of the parallaxes themselves.

THE OLD BABYLONIAN VENUS TABLES.—A note in these columns more than a year ago described Dr. Fotheringham's work in dating these tablets, which are an important source for early chronology. Father Kugler was the first to deal with the problem, and fixed on the dates -1800 to -1780 for the series of observations contained in the tablets. Dr. Fotheringham made the dates 120 years earlier (they must be shifted by multiples of 8 years, owing to the fact that both Venus and the moon nearly repeat their positions relatively to the sun after this period). Dr. C. Schoch has lately been visiting Dr. Fotheringham at Oxford, and has just published a pamphlet entitled "Ammizaduga," which makes a further alteration in the dates, making them -1856 to -1836. One difficulty in the research is the question of intercalary months, with regard to which Ammizaduga appears to have changed the system. Light is thrown on them by study of the tablets relating to the harvests of dates and barley, as these give an indication of the position reached by the sun. It is claimed that, taking all the circumstances into account, the dates now adopted are the only ones that satisfy all the data. The mean dates of Nisan 1 reduced to Julian reckoning are given as follows:

Year	0	Nisan 1 = Apr.	7, 15 days after equinox.
" -1000	"	Mar. 30,	1 day before equinox.
" -2000	"	Mar. 29,	9 days "
" -3000	"	Apr. 1, 14	" "

## Research Items.

**PHYSICAL CHARACTERS OF SERBIAN GYPSIES.**—Dr. Viktor Lebzelter has recorded in the *Journal of the Gypsy Lore Society*, Ser. 3, vol. 3, Pt. 4, the results of anthropometric observations made in 1916 on forty-five Serbian gypsies who were prisoners of war. Gjargjević has classified the gypsies of Serbia into three strata, of which the first and third are Moslems and the second Christian—Rumanian gypsies who with the other Rumanian inhabitants of Serbia entered the country in the seventeenth century. The subjects of Dr. Lebzelter's observations belonged to the Christian stratum, though only seven called themselves Rumanian gypsies. They came from north-west Serbia and all were sedentary. They were remarkably homogeneous. Their hair was thick, and smooth like that of Hungarian and Bosnian gypsies. In the majority of cases it was black, but ranged to light brown. The colour of the iris in eighteen cases was dark brown, but black-brown, brown, greenish-grey, brownish-grey, and greenish-brown also occurred. The average height was 1627 mm.; 24 per cent. were tall or very tall. The cephalic index ranged from 72.49 to 88.76, the average being 78.3. From an analysis of published measurements of Balkan gypsies, 952 individuals, Dr. Lebzelter concludes that the original type is dark, smooth-haired, moderately short, mesocephalic, moderately hypsiccephalic, leptorhine, and perhaps leptoprosopic. The Serbian gypsies show this original element more clearly than the Hungarian gypsies.

**TRIBES OF THE GRASSLAND AREA, CAMEROON.**—Capt. L. W. G. Malcolm has contributed to *Mitt. Anthropol. Gesellschaft in Wien*, Bd. 55, a detailed study of the physical anthropology of the Eyap tribe of the Central Cameroon. The observations were confined to males, forty-four measurements being taken on each of one hundred individuals between the ages of twenty and fifty years out of a total adult male population of not more than 700. Five albinos with eyes hazel to green in colour were seen, and *leucoderma* on hands and legs is common in both sexes. Deformations include elongation of the head, the infant's head being moulded by the mother soon after birth, moulding of the nose, piercing of ears, lower lip, and septum of the nose, chipping of the teeth, circumcision, cicatrization, and tattooing. The ratio of males to females is 25.92 per cent. The rate of infant mortality is high, and the number of children in polygamous families low. The head-chief, with more than 100 wives and concubines, had twenty-five children, of whom only five were living. Other chiefs with wives numbering between twenty and fifty had even fewer, and in nearly all cases there are more children by monogamous marriages. The maximum head-length recorded is 205 mm., the minimum 180 mm., the mean cephalic index 79.37. While the Eyap are mesaticephalic, according to the usual classification, they show a strong tendency to brachycephaly.

**THE RELATIVITY OF TIME.**—An article in the February issue of *Scientia* by Prof. F. Severi of the University of Rome deserves the attention of all who are interested in the philosophical aspect of the principle of relativity. It is an examination of objections of a general kind to the relativity of time. The argument deals with three objections to Einstein's definition of simultaneity: "Two flashes produced at equal distances from me are simultaneous if I perceive them at the same instant." The first objection is that the definition depends on a concept of simultaneity which is spontaneous and intuitive, the very concept the definition seeks to get rid of.

The second is that logically the definition is circular, for it presupposes that the light reaches me from the two places at which the flashes are produced in equal times, whilst I can only measure intervals of time if I already possess the notion of simultaneity. The third is that the hypothesis of the independence of the velocity of light of the motion of the source and of the observer is *a priori* untrustworthy, because it precludes our thinking of a light phenomenon in the concrete, that is, as a phenomenon arising, developing, and finishing within its own environment. Prof. Severi, in replying to these objections, concludes a very lucid argument with the opinion that, so far from the principle of relativity having, as some have claimed, removed the last anthropomorphic vestiges from science, absolute time is both egocentric and anthropomorphic; and, however we regard the universe, whether as a reality external to us or as the projection of a construction of our mind, the maxim of Protagoras remains profoundly true: man is the unity of the measure of the universe.

**DIFFERENTIATION OF BREEDS BY SEROLOGICAL METHODS.**—The *Journal of Immunology* (vol. 9, No. 6, November 1924) contains a paper by W. Bialosuknia and B. Kaczkowski, of the Institute for Serological Research and the Animal Breeding Department of the Institute for Agricultural Research in Poland, on the problem of determining the descent of certain breeds of sheep by applying the methods previously adopted by Londsteiner and others in their researches on the isoagglutination of blood among races of men. The sheep employed in the investigation were South-downs, a local Polish breed, a mountain breed from the Carpathians and Karaculs. It was definitely shown that whereas certain types of erythrocytes are agglutinated by all the sera having the capacity for agglutination, others are only agglutinated by certain sera, and that the sheep investigated fell readily into groups according to the results of the isoagglutination test. It was impossible, however, to distinguish the breed of sheep by this test, since the same groups were present within the various breeds. Nevertheless, evidence was obtained of the existence of serological characteristics which could be transmitted in accordance with Mendelian expectation. It was found, moreover, that external factors played no part in the phenomena of isoagglutination. The authors are pursuing the subject further.

**HERRING INVESTIGATIONS.**—The report for 1923-24 of the Dove Marine Laboratory, Cullercoats, Northumberland, drawn up by Prof. Meek, contains an account of a large amount of work. Following up his researches on herrings Mr. B. Storrow, who for many years has made this his speciality, contributes a detailed paper on herring shoals in which he reports on more than 7000 examples from various localities. He finds that those from the Smalls and from St. Ives were of mixed growth and practically all mature, making it difficult to fix separate races. From examination of the scales of the various herrings he makes the suggestion that the larger growth variations, as indicated by these scales, are to be interpreted as representing periods of migration to or towards areas of greatest growth which are oceanic, and he concludes that in the case of the North Sea herrings, a northerly migration is necessary to bring about a more rapid increase in size. Mrs. Cowan adds a report on the size of the herrings showing that various shoals of different sizes and ages appear at different times.

**EXPERIMENTS ON ECHINODERMS.**—The report for 1924 of the Marine Biological Station at Port Erin,

Isle of Man, by Prof. Jas. Johnstone, states that most of the research done at that laboratory has been published elsewhere, the amount of this work showing abundant activity on the part of the staff. In the appendix, however, there are two interesting papers, one by Mr. J. Ronald Bruce, naturalist of the Port Erin Station, on the seasonal and tidal P<sub>2</sub> variation in the waters of Port Erin Bay, and one by Mr. H. C. Chadwick, research zoologist, entitled "Natural History Notes," in which he gives some recent plankton observations and describes some very interesting experiments on the vitality of the spines and pedicellariæ of echinoderms from detached portions of the test. It is shown that these may still respond to stimuli after thirteen days, and pedicellariæ alone when detached from the test may retain their vitality almost as long as when *in situ*. With regard to the unnamed larva figured in these notes, there seems no doubt that it is the free-swimming cercaria of the trematode *Pharyngogora bacillaris*, which is to be found fairly commonly in the Channel in the winter months and is conspicuous in having an annelid-like tail regularly provided with setæ. The intermediate host may be a medusa or a ctenophore, in which it lives freely without encystment, and the final host is the mackerel. The parasitic ciliate protozoon *Cryptochilum boreale* in *Echinus esculentus*, from the Shetland Islands, recently described by Mr. C. C. Hentschel, is found to be common in the Echini from Port Erin.

**POLLEN DEVELOPMENT IN SWEET PEAS.**—The extensive genetical studies of *Lathyrus odoratus* by Bateson, Punnett, and others make a critical investigation of the cytology of this species desirable. In a preliminary account of such a study (*Brit. Journ. Exptl. Biol.*, vol. 2, p. 199), Miss J. Latimer describes some of the features of the pollen development. The haploid chromosome number is already known from the work of Winge to be seven. In the second contraction stage of meiosis, the spireme is thrown into seven radiating loops, and for this stage Prof. Gates suggests the term broxonema. Each loop consists of a pair of chromosomes end-to-end. When the thread is still very slender the arms of the loop are frequently twisted about each other near the base. This would provide a possible basis for crossing-over combined with telosynapsis. Hitherto crossing-over has only been described in connexion with parasynapsis or a side-by-side pairing of chromosome threads. The view is also expressed that the linin rather than chromatin is the probable basis of inheritance.

**ANIMAL ATTACKS ON LEAD TUBING.**—At the Linnean Society on March 5, Mr. Gerald Loder showed a piece of lead piping from Waterloo Station, London, gnawed by rats. "The general opinion was that the rodents gnawed the metal in order to wear down their teeth, and not to reach the water or to enlarge a passage-way." The destruction of lead tubes by animals is also discussed by Prof. R. Hesse of Bonn in the *Biologisches Zentralblatt*, Part I., for 1925. He here explains the action of the rats in gnawing through a tube of 4 mm. thick as due to their endeavour to penetrate from a cellar into a basement, an endeavour which a stream of water from the pierced pipe would presumably throw considerable cold water upon. Dr. Hesse describes other examples of metals being attacked; thus in Shanghai species of *Xylocopa* eat through the lead sheath on telephone cables, although it is 0.8 mm. thick. The correspondent of a cable company explains that these "wasps" mistake the cables for bamboos and bore the holes in order to deposit their eggs therein! As soon as a rough "twine braiding" is wrapped round the smooth cable, it no longer has attraction for them and they leave it alone. The same cable firm reports the penetration of a sub-

marine cable, armouring, jute and lead sheath, by chitons, which had slowly penetrated even the lead tube presumably by the slow chemical action of acid substance excreted from the foot.

**THE SARCOPT OF THE BUFFALO.**—T. M. Timoney gives an account in *Bull. 154, Agric. Res. Inst., Pusa, 1924*, of the bionomics of this parasite as observed at Muktesar. The average number of eggs laid by a female under experimental conditions was 17 to 18, and ten days was the maximum duration of life of an egg-laying female. The incubation period of the eggs is 1 to 2 days at summer temperature, and 2 to 3 days in winter. The interval between hatching from the egg and attaining adolescence is 6 to 8 days. The ovigerous and pubescent females can withstand better than the other stages separation from their host. The author records tests with 10 per cent. creosote in olive oil, which suggests that it may be found effective in controlling this sarcoptid.

**TEXTURE AND STRUCTURE.**—In the *Geol. Fören. Forhandl.* Bd. 46, Dec. 1924, pp. 654-660, P. J. Holmquist summarises the different definitions and usages of the petrographic terms "texture" and "structure." There is more diversity of opinion with regard to the latter term than to the former. Iddings, for example, applies "structure" to features due to fracture, aggregation, or erosion; whereas many Continental petrologists have used the term in the Anglo-American sense of "texture": that is, to connote the manner in which the internal units of a rock are arranged. Holmquist suggests that the confusion be brought to an end by accepting the meanings given by Holmes in his recent "Nomenclature of Petrology," these being also the meanings that have long been adopted by Törnebohm and other Swedish petrologists. "Structure" is thus applied to the appearance of a composite aggregate which is itself made up of simple aggregates, and each of the latter has a "texture" due to the degree of crystallisation, the grain size, and the shapes and interrelations of the crystals or other constitutional units.

**EQUIPMENT FOR ARCTIC EXPEDITIONS.**—The plans of the *Terra Nova* and a detailed list of its equipment and stores during its employment with Captain Scott's expedition form one of the most recent publications of the British Antarctic Expedition (1910-13) (London: Harrison and Sons, London, 5s. net.). The publication, which is edited by Col. H. G. Lyons and is entitled "Miscellaneous Data," contains also some notes on equipment and transport animals which should prove useful to expeditions of the future. It is of interest to note that the mules used by the search party in 1912 seemed far better suited to the Antarctic conditions than the ponies which Captain Scott used in the earlier stages of his southern journey. They were Indian pack-mules trained for snow work in the Himalayas. The volume also includes a short note on the tidal observations.

**MOVING RAINBOWS.**—In *NATURE* of Dec. 13, 1924, p. 860, Mr. G. B. Deodhar described some interesting observations made by him of a double and mobile rainbow. Mr. G. Fergus Wood, of the Forest Research Institute, Dehra Dun, writes to say that he happened to witness a somewhat similar phenomenon a year or so ago. He says: "I had just taken some readings with a theodolite in the early morning when an incomplete rainbow appeared in the sky above the point which I had been observing. The sky was clear, with the exception of a few clouds in the neighbourhood of the shower responsible for the bow. I elevated the telescope to look at it; as I did so the bow began to move rapidly out of the field of view so that I had

to depress the instrument to follow it. The movement was about  $3^\circ$ . I could detect no change in colour sequence or in radius, though the final bow seemed brighter and was complete. The movement lasted less than thirty seconds." Mr. Wood does not agree with Mr. Deodhar's explanation of two bows appearing in the sky close together and with the same colour sequence. He remarks: "I am inclined to attribute both phenomena to either a reflection or refraction of the sun's rays before entering the rain, or to a reflection (unlikely) or refraction between bow and observer. The latter—in the nature of a mirage effect—seems to me the most probable, since the time was favourable and magnification is frequently the result of mirage."

**THE THEORY OF STRIATED DISCHARGE.**—An explanation of the mechanism of the striated discharge, based on recent investigations of collisions between electrons and atoms, is given by Prof. A. Günther-Schulze in the *Zeitschrift für Physik* for February 11. He shows that in many gases, even when the collisions are inelastic, the velocity of the electrons, which move irregularly in all directions, increases in an electric field up to a definite maximum value. He gives the law which governs the velocity at different distances from the cathode, where it is zero. If the velocity expressed in volts is less than the excitation voltage of the gas, the losses on collision with the atoms will be small, and there will be no luminosity; when, however, the velocity reaches this point, the energy of a colliding electron will be given up to the atom, which will emit light. This will take place at a definite distance from the cathode, and the first bright stria will be produced, the velocity of most of the electrons being reduced to zero. It is known that faster electrons are not so likely to produce excitation as those that have the excitation velocity, and most of the former will pass on into the succeeding dark space, where they will not produce luminosity. The same is true of the electrons which have been brought to rest in the first stria, which will gradually acquire velocity as they pass through the dark space, and will excite the atoms in a second narrow zone when they have acquired the correct velocity.

**THE ABNORMALLY LOW VOLTAGE ELECTRIC ARC.**—Dr. R. Bär describes experiments with mercury vapour, argon and helium in the *Zeitschrift für Physik*, February 19. With mercury the smallest excitation voltage ( $1S-2p_2$ ) is 4.7 volts, and the voltage corresponding to the resonance line  $2537 \text{ \AA.U.}$  ( $1S-2p_2$ ) is 4.9 volts; but Hebb found that an arc would burn with 1.7 volts and Yao with 1.8 volts. The author's experiments were directed towards finding whether such low voltages would suffice when there were no oscillations in the current and voltage, and his result was that the lowest steady voltage which would give an arc was 2.25 volts. Previous experiments by Bär, v. Laue and Meyer have shown that the arc produced in helium, at 8 volts, by Compton, Lilly and Olmstead was due to oscillations in the voltage, the peak voltage rising above the critical value 19.8 volts. The author has now succeeded in producing an arc in helium with a steady voltage of 16.5 volts, using specially purified helium and a very hot cathode wire.

**A SUGGESTED EXPLANATION OF THE QUANTUM THEORY.**—M. L. de Broglie, in the *Annales de Physique* of January-February, assumes the existence of a periodic phenomenon, the exact nature of which has still to be determined, which is connected with every isolated "portion of energy," including electrons, protons, matter in general, and quanta of light and

X- and  $\gamma$  rays. The fundamental idea of the theory of quanta is the impossibility of considering an isolated quantity of energy without associating with it a certain frequency, in accordance with the equation  $E = h\nu$ , which must be connected with the mass of the energy portion, or mobile, by the Planck-Einstein equation. Considering the question in the light of the relativity theory, it is found necessary to associate with uniform motion of a material point a certain wave propagated from it, the phase of which is displaced in space with a constant velocity greater than that of light. In the more general case of an electrically charged body, moving with variable velocity in an electromagnetic field, it appears that the principle of least action in the form given by Maupertuis, and Fermat's principle of concordance of phase, may be two aspects of a single law. The known laws of quantified trajectories can be interpreted as expressing the resonance of the phase wave along the length of closed or quasi-closed trajectories; this appears to the author to be the first physically plausible explanation proposed for the Bohr-Sommerfeld stability conditions. The theory leads to a real harmony between the views of Newton and of Fresnel; but it is shown that the electromagnetic theory requires revision, though as a statistical approximation the existing theory is perfectly satisfactory in a very large number of cases. The scattering of X- and  $\gamma$  rays, statistical mechanics, and the law of radiation of a black body are dealt with in accordance with the new theory.

**HOLMIUM.**—F. H. Driggs and B. S. Hopkins describe in the February number of the *Journal of the American Chemical Society* some work carried out on holmium. Holmium and yttrium were separated from erbium by fractional crystallisation of the bromates; yttrium was removed by thermal decomposition of its nitrate. The ratio of holmium chloride to silver was determined, the results giving a mean value of 163.47 for the atomic weight of holmium.

**THE CALOMEL ELECTRODE.**—A method of preparing calomel directly in saturated potassium chloride solution is described by W. W. Ewing in the *Journal of the American Chemical Society* for February. A current of 1.3 amp./dc. at 35-40 volts was applied to the system  $Hg^+ KCl(\text{sat.}) N KCl CuCl_2(\text{sat.}) Cu$ . Calomel mixed with potassium chloride crystals and finely divided mercury collected on the mercury surface, which was continually scraped with a stirrer. This method is less tedious than the older one, and the product is shown to be a dependable standard for use in the calomel electrode.

**THE HABER EQUILIBRIUM.**—It has recently been found that the equilibrium constant of the Haber equilibrium (hydrogen, nitrogen and ammonia) is a function of pressure, and it follows that such data can be used, at least in principle, to test assumed forms of the mass action law. Existing data must be supplemented with hypotheses, however, enabling us to pass from the properties of pure gases to those of mixtures; and L. J. Gillespie, in the February number of the *Journal of the American Chemical Society*, points out that the rule of Lewis and Randall for calculating the fugacity of a gas in a mixture offers a suitable hypothesis, provided it is made exact by the addition of a certain supplementary term based on the assumption that at large volumes the equilibrium pressure is equal to the ideal-gas partial pressure. The author shows thermodynamically that the three propositions—exactness of the modified fugacity rule, additivity of volumes and additivity of heat content—all follow from any one of the three. An experimental method is outlined for testing the author's results.

## Submarine Measurements of Gravity.

RECENT years have witnessed great advances in our knowledge of the gravitational field near the earth's surface on land, but in spite of many efforts the extension of these determinations to oceanic regions has until quite lately proved a very intractable problem. It would now seem that substantial success has at last been achieved, as the result of trials of a specially designed apparatus and method during a voyage of a submarine from Holland to Java in 1923. The apparatus used is a development of one which was devised to overcome difficulties experienced in ordinary pendulum determinations in Holland, where the unusual mobility of the soil had made it impracticable to eliminate slight movements of the supports. These motions were rendered innocuous by suspending from the same plate several pendulums, having very nearly equal periods of vibration, and causing them to vibrate in different phases. The success of this device led to its trial at sea also, on a steamer of 1200 tons, but the weather was bad and the pitching and rolling of the vessel spoilt the attempt. Prof. van Iterson, Director of the Netherlands State Mines, then suggested that these disturbances might perhaps be avoided, or sufficiently reduced, by making observations on a submerged submarine instead of on a floating vessel. Preliminary trials confirmed the value of this proposal and arrangements were then made for a more exhaustive test.

Dr. Vening Meinesz, who was responsible for the investigation, has recently published a provisional account of the work.<sup>1</sup> The apparatus (made by Stüchtrath) consisted of two pairs of pendulums suspended from the same plate, oscillating in opposite phases, two by two in planes at right angles. Their oscillations were recorded photographically. The pendulums were of brass, which led to difficulties in connexion with their large temperature corrections,

<sup>1</sup> "Observations de Pendule sur la Mer pendant un Voyage en sous-marin de Hollande à Java, 1923." Publication Provisoire par Dr. F. A. V. Meinesz.

since the temperature in a submerged submarine quickly rises; invar pendulums could not be used because of their susceptibility to magnetic fields, which are scarcely avoidable in a submarine. Dr. Meinesz suggests that errors arising from this source should be reduced in future experiments, either by the use of quartz pendulums, or by shielding the instrument from changes of temperature. The apparatus was mounted on a large wooden stand, which was not so firmly fixed as not to require watchful guard against shocks. It was placed as near to the metacentre of the submarine as possible.

Successful experiments were made in the Mediterranean and in the Indian Ocean. The pendulums were swung for periods of fifteen to twenty minutes, but rather longer periods, up to thirty or forty minutes, are recommended in future work. The various sources of error are discussed by Dr. Meinesz, who concludes that the mean error of a determination of the time of oscillation of a pair of pendulums in calm weather was 2 to 3 units of  $10^{-7}$  second, and in rough weather, with the submarine at a depth of 20 or 30 metres, about  $10 \times 10^{-7}$  second.

This work by Dr. Meinesz was recently described by Colonel Lyons at a Geophysical Meeting of the Royal Astronomical Society, and it was urged that similar work should be carried out by other countries. Sir Gerald Lenox Conyngham discussed the results obtained (in Dr. Meinesz's provisional report this is not done, nor is any chart or topographical description of the observation points given, except latitude, longitude, and the depth of the ocean). The observed values of gravity far out at sea differ sufficiently little from the computed normal values to indicate that there must be isostatic compensation. Near land the compensation seems to be less complete, and it was stated that Dr. Meinesz infers a greater extension of the compensating layer below the mainland than is required by the theory of isostasy.

## Factors influencing Growth in Trees and Plants.

THE Carnegie Institution of Washington has recently published the results of a further very interesting series of investigations on growth in trees and massive organs of plants.<sup>1</sup> Prof. D. T. MacDougal's dendrographic measurements provide considerable additional information on the behaviour of tree-trunks. The investigations, which were conducted chiefly on conifers, but also on broad-leaved species, cover the duration of the growing season, seasonal activity, the increase of wood and of roots, the path and rate of movement of liquids in stems and the general use of the dendrometer for measuring the yearly increase in the circumference of stems. In addition, auxographic records are obtained of the growth of *Opuntia* stems and flowers, *Mesembryanthemum* leaves, potato tubers, and the fruits of *Cucurbita*. The experiments were conducted principally on plants grown in the open and under the full influence of their habitual environment so that the normal activity of the plants was not disturbed. Amongst the interesting conclusions to which Prof. MacDougal directs attention in his summary the following may be noticed.

In the investigations on the Monterey pine (*Pinus radiata*), it is observed that the duration of seasonal growth is longest in young trees, whilst wide differ-

ences are exhibited by older trees. The thickness of the woody layer shows a general correlation to the length of the growing season but no constant relation to the total amount of rainfall; it is more likely to be due to the favourable conjunction of a number of factors in which seasonal relative humidity may be an important agent. The flow of solutions, as shown by the use of dyes, is found to be much greater late in the season than in the stage of rapid growth, and confirmation is obtained that the sap travels chiefly in the wood of the two previous years. Several other interesting associations of facts in connexion with the movement of liquids and variation in girth of stem are also recorded.

In general, it is found that practically all organs or members tested with the dendrograph show daily equalising variations in size and volume in direct relation to their water-balance, and that these daily equalising variations are characteristic of each species. Further, the results of these investigations show that the amplitude of the daily variation is not dependent upon the softness of the wood and the character of the bark.

The development of potato tubers, as recorded by auxographic apparatus, shows that the period of enlargement may be estimated at 90 to 100 days, and that their behaviour is comparable to that of nuts and fruits.

The second part of the bulletin contains Dr. Forrest Shreve's records on the growth of trees. A series of

<sup>1</sup> "Growth in Trees and Massive Organs of Plants. Dendrographic Measurements," by D. T. MacDougal; "The Growth Record and Analysis," by Forrest Shreve. (Publication 350.) Pp. 116. (Washington: Carnegie Institution, 1924.) 1.50 dollars.

detailed analyses of stems of different ages and a consideration of the results obtained of growth in relation to rainfall and temperature lead to some very interesting conclusions. Examination of trunks of pine and redwood shows that the annual rate of growth is not the same at the stump and at different heights in the trunk, and that it is greater toward the centre than towards the periphery. No definite correlation is found between growth and rainfall and growth and temperature, and the conclusion drawn is that the annual growth of the specimens examined is dependent on the general complex of environmental conditions and not on any one particular factor.

A further contribution to this study has recently been published in the Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan.<sup>2</sup> The experiments, which took place in the University Botanic Garden at Sapporo, were conducted to show the influence of meteorological factors on the growth of trees, or, more precisely, on the girth of the trunk. Prof. Hirokichi Nakashima was fortunate in being able to select a healthy young specimen of *Abies Mayriana*, about 50 years old, which was growing at a convenient distance from a meteorological station.

Until recent years it was supposed that the girth of the stem increased continually from spring to autumn, and that in winter during the resting period the girth remained unaltered. The experiments, however, showed that even in winter appreciable increase and diminution in girth took place, depending chiefly on meteorological factors. In fact each cycle of development may be divided into four periods. During the vegetation period, from the end of April to the end of October, precipitations proved the most important factor. The relations between transpiration and absorption were the determinants through the autumnal transition period, the month of November, and the late spring period March and April. During the resting period, from mid-December to the beginning of March, the temperature of the air was the chief factor. Prof. Nakashima has been able to express these relations in formulæ. The conclusions drawn are that increase in girth depends either on growth or on the swelling of water-containing tissue; changes in girth are connected with transpiration and absorption; increased transpiration without corresponding water-absorption by the roots causes decrease in girth; prevention or reduction of transpiration during absorption causes swelling of the stem, and, generally, increase and decrease of girth are closely connected with meteorological conditions.

The article is accompanied by the daily meteorological observations and experimental records of the whole period of five years during which the experiment lasted. The apparatus used for measuring the varying size of the stem was Friedrichs Zuwachs-autograph.

<sup>2</sup> "Über den Einfluss meteorologischer Faktoren auf den Baumzuwachs, (1) Über den Einfluss . . . eines Tannenbaumes," by Prof. Hirokichi Nakashima, Journal of Agriculture, Hokkaido Imperial University, Sapporo, No. 2, p. 69. Published by the University, Sapporo, November 1924.

### Haddock Biology.

THE first part of a paper on the biology of the haddock, by Mr. Harold Thompson, was referred to in NATURE, August 30, 1924, p. 333. The second part, on the frequency and distribution of the age classes in 1923, which has recently been issued,<sup>1</sup> gives an account of later investigations. In the first part it had been shown that the year 1920 had produced

<sup>1</sup> Fishery Board for Scotland: Scientific Investigations, 1924. No. 1, Haddock Biology; No. 2, Frequency and Distribution of the Age Classes in 1923. By Harold Thompson. Pp. 48+4 plates. (Edinburgh and London: H.M. Stationery Office, 1924.) 5s. net.

a remarkably large brood of young haddock, which in 1922 were beginning to show in the commercial catches as two-year-old fish. We now learn that in 1923, as Mr. Thompson had ventured to predict, these fish had become the mainstay of the North Sea haddock market, and that they constituted 70.5 per cent. of all the haddock captured, so far as these were sampled.

The years 1921 and 1922 were both failures so far as the young brood of haddock in the North Sea was concerned, but it is pleasing to note that 1923 was one of the best years on record. If all goes well with the brood, these fish should become prominent in the commercial catches in 1926 as three-year-old fish. Mr. Thompson was able during 1923, by a detailed study of the scales of this group of haddock, to establish still more closely the relation between the growth of the scale and the growth of the fish. He shows that the scales first formed on the fish are those which lie immediately below the third dorsal fin, and if scales from this position in older fishes are selected for examination, it will be found that the length of the fish at the end of each growth-year can be determined correctly on the assumption that the growth of the fish is directly proportional to the growth of the scale. On the other hand, scales from below the second dorsal fin will give a calculated result about half a centimetre short, and those from below the pectoral fin 2.75 cm. short. This is an important point to have established and will clear up many of the difficulties which those working at problems of the growth-rate of fishes have encountered.

Further observations are recorded on haddock from Iceland, the Faroes, and from the Norwegian coast. The rate of growth of Iceland and Faroe haddock appears to be much greater than that of North Sea fish, but in Iceland the rate decreases from the south coast, by west and north to the east coast, where it is smallest. Good survival years for the brood at Faroe, Iceland, and Norway differ from each other and from those of the North Sea.

### University and Educational Intelligence.

ABERDEEN.—At the graduation ceremony held on April 1, the degree of D.D. was conferred on the Right Rev. E. W. Barnes, F.R.S., Bishop of Birmingham.

LONDON.—The two following courses of free public lectures at King's College are announced. "Problems of Modern Physics," Prof. W. Wien, on April 21, 22, and 23; and "Recent Advances in the Study of Living Cells," Prof. R. Chambers, on April 27, 28, and 29. The lecture hour in each case will be 5.30.

THE Council of the University College of Southampton is to award two open exhibitions in engineering to candidates who may or may not be now resident in the district. The awards will be made on the recommendation of the Engineering Faculty Board without formal examination, provided the candidates have matriculated and are prepared to read for a degree in engineering.

THREE open scholarships, each of the yearly value of 40l., some bursaries of 20l., and others covering the tuition fees in commerce are being offered in competition by University College, Leicester. The examination will be held at the College in June. Particulars may be had from the secretary.

If industrial prospects in Great Britain are at present clouded, good progress can be recorded in

the direction of improved social service. The activities of the Carnegie United Kingdom Trust, as set forth in the eleventh annual report, may be summarised as an attempt to restore to the English people the amenities of life which their forefathers enjoyed, and of which they were deprived by an over-rapid development of the factory system. The library policy of the Trust has, as is well known, been directed to the provision of facilities for reading in the rural districts by the establishment of County Library schemes reinforced by Central Loan Collections. Grants for the establishment of County Libraries have now been made in eighty-six counties in the United Kingdom of Great Britain and Ireland, and in the course of a few years these will all be on an independent basis. The development, however, of the Central Loan Collections on self-supporting lines presents many difficulties. The cost of the administration of these national book stores is likely to increase more rapidly than the income from the contributory libraries, and it is clear that in the long run some assistance will have to be provided by the State. In the meantime the grant to the London Central Library has been increased from 1000*l.* to 3000*l.*, at which sum it will be maintained for the next four years. Other activities of the Trust in the direction of fostering the national talent in musical composition, the drama, and folk-dancing continue to show satisfactory results. The Margaret Carnegie Hostel for girls at Portree was officially opened last October, and a large grant has been made for the purchase of a building in East London to be used as a hostel for boys.

VISUAL Education Departments in Educational Institutions form the subject of a report published in Bulletin, 1924, No. 8 of the United States Bureau of Education. Of 78 State universities and State colleges, 20 have departments sufficiently well organised to employ special officials to handle visual aids. They are generally organised as parts of the university extension divisions of these institutions, but the work is not entirely extra-mural, and the departmental heads attend faculty meetings. The growth of these departments is described as a teacher movement and not a commercial development: on the contrary, it is a development in despite of the commercial exchanges, which have sided with the theatres in their opposition to supplying films to educational institutions. Five departments undertake the actual production of films. Columbia University has a course in moving-picture production, and the University of Nebraska is said to have built a 20,000-dollar moving-picture studio on its campus. The University of Wisconsin has purchased the negatives of a large group of educational films, and sells the prints direct to other institutions at about 60 dollars per reel of 1000 feet—considerably less than what commercial firms charge. The United States Department of Agriculture and the Bureau of Mines have done much to popularise instruction in agriculture and in mining and metallurgy by the use of films and slides. The Bureau of Mines contrives to produce films without any expense to the Government beyond the salary of an engineer, who assists in planning and directing the work to assure its being worthy of circulation, the whole of the rest of the cost of production and making the copies being borne by the industries filmed. Colleges, high-schools, and churches are the largest users of these films. Though films figure largely in the report, they are by no means universally considered the most useful of visual aids. The slide has a decisive majority vote for usefulness. Much use is also made of stereographs and exhibits of objects from museums.

### Early Science at Oxford.

April 13, 1686. A discourse concerning Hydraulic Engines, drawn up by Mr. King of Dublin, was communicated by Mr. Ash: the Society ordered their thanks for this ingenious discourse, both to Mr. Ash, and Mr. King.

Mr. Caswel communicated a Mathematicall paper containing the Solutions of severall problemes, composed by Mr. Baker of Bishops Nymton in Devonshire.

April 14, 1685. Mr. President communicated a farther discourse concerning ye Air's Gravity observed in ye Baroscope, occasioned by that of Dr. Garden read ye last meeting. He also communicated ye following observation; that at Dover, on March 19 last past, (which was two daies after the last quarter of ye Moon) there was observed this extraordinary in ye Tide: After it had flowed some time, it ebbed two foot; then flowed again, and then ebbed; and after flowed a third time, and so a fourth time: so that there were four flowings, and three ebbings in one Tide.

A Letter from Mr. Cony, dated Rochester March 27, was read concerning the raining of Fish, as it was supposed to have been in that countrie some time since.—Mr. Cole of Bristoll mentioned a substance proceeding from Calamy oar, which far exceeds, in colour and finenesse, all metalls, beside gold, and silver.

April 15, 1684. Mr. Pulleyn informed ye Society, that an Elm, split at Cumnor, during ye late frost, was observed to have Ice in it: It was affirmed that vines have been split this winter, more frequently towards ye South, than any other, point of ye compass; and that they split more in ye Thaw following ye great Frost, than in ye frost itself: ye reason of ye former may be, because vines lye most open to ye South, and partly also (as Mr. Walker imagins) because ye sap-vessells are largest, and ye quantity of ye sap greatest in ye south side of ye vine, as in other Trees. Dr. Smith did himself observe, that ye Cedars of ye Physick garden, raised from seeds brought out of Syria, bore ye shock of ye frost, without being any way damaged. Mr. Crouch was desired to enquire, whether ye Cedars of Balliol College were any way injured. A Letter dated Aprill 10th, from Mr. Aston, Secretary to ye Royall Society, was read; which questioning whether a body, in shape like ye heel of a Shooe, presented by my Lord Bishop of Lincoln, to Dr. Plot, being esteemed as a Petrification of leather, be any thing more then a bare Incrustation. For ye satisfaction both of ourselves, and ye Royal Society, it was ordered, that this (supposed) Petrification should be examined, as to its make, and texture; more especially by boring it: Mr. Wm. Piggot tooke this charge on him.

Three papers of Dr. Lister's concerning thunder &c. proceeding from Pyrites; and a letter from Sir R. Southwell concerning ye compasses of a Ship being changed by lightning, were read.

A Peice of black Brittish Marble, spotted white, found in ye grounds of Mr. Wogan of Bolston in Pembrokeshire (who uses this sort of stone for ye makeing lime) was communicated to ye Society, by Dr. John Floyd, Vice-chancellor of ye University. It was ordered to be put in the Ashmolean Museum. This led us to discourse of sawing marble. It was affirmed by Mr. Wheeler that Little Veins, called *puns* by ye stone-cutters, run up and down, and are sometimes so many and so hard, that they dull ye teeth of ye tooles, so that many times it is not worth ye while to worke ye stone.

## Societies and Academies.

## LONDON.

**Royal Society, April 2.**—H. E. Armstrong: Studies on enzyme action, xxiii. The oxidase effect and the phenomena of oxidation in general: carbonic oxide. —N. K. Adam and G. Jessop: An explanation of the so-called "intertraction phenomenon" between solutions and the molecular significance of negative surface tension. Solutions mix by sending out streamers into each other only (1) if they are superposed, and (2) if there is a difference in rate of diffusion between the dissolved substances. The streamers are due to the different rates of diffusion between the two liquids disturbing the hydrostatic equilibrium of the layers. Capillary forces are not concerned. The movements are entirely different if (1) the faster, (2) the slower, diffusing solution is superposed. With these restrictions the phenomenon seems to be general, but it involves no unknown forces. "Negative interfacial tension" means that the inward attractive forces which, when surface tension is positive, prevent molecules from escaping across the surface of the liquid, become negative. It is properly manifested in diffusion away from the body of the liquid.—Jane Sands: Investigation of oxidation in the blood of earthworms.—R. Snow: Conduction of excitation in the leaf of *Mimosa spegazzinii*. Simultaneous determinations were made of the velocities of the water current and of the excitatory conduction set up by cuts in the leaves. The latter is many times the more rapid. After the stimulus of a burn, conduction is much more rapid again. Excitation is conducted much more rapidly in the leaves of shoots totally submerged under water for several hours than in leaves attached to the plants in air. In very damp air the velocity of conduction in the leaf is increased to a less extent. Excitation is conducted down the leaf pinnæ with great acceleration, and this depends in part on the nature of the process of conduction itself. In the leaf of *M. spegazzinii*, excitation is regularly conducted by some mechanism that has nothing to do with the water current. Changes of pressure in the tube-cells play no part in conducting excitation, even in the leaf—Dorothy Adams: Investigations on the crystalline lens. The lens resembles other tissues in possessing an autoxidation system made of two sulphur-containing components: (a) water-soluble glutathione; (b) a thermostable protein residue. Experiments were made on fresh ox lenses, and oxygen uptake was measured directly and indirectly. Fresh lens has a definite oxygen uptake, evidently used for maintenance of its autoxidation system, since any alteration in concentration of glutathione in the lens causes corresponding change in oxygen uptake. The average glutathione content is higher than that of other more vascular tissues. The thermostable protein residue has no oxygen uptake; but with a few milligrams of glutathione it gives an oxygen-uptake curve exactly similar to that of fresh lens. Exposure of fresh ox lens to ultra-violet light or to heat rays causes measurable decrease in its glutathione content.

**Royal Microscopical Society, February 18.**—W. Bernard Crow: Variation in the hormogones of *Lyngbya nigra* Ag. The hormogones of the blue-green alga, *Lyngbya nigra* Ag., arise by division from the parent filament, the separation being effected by separation discs. Secondary separation occurs in the free hormogones, leading to the formation of very short hormogones. Some of the latter consist of a single segment only, but do not show the characters of spores. The separation discs, which are

special deposits in the protoplasm, sometimes occupy a single segment. Ordinary transverse walls are occasionally absent at certain points in the trichome. Conjugations of adjacent segments in other Cyanophyceæ are interpreted as special cases of failure of transverse wall development.—W. L. Roche: Notes on the microscopic anatomy of the tentacular sense organ of *Cardium edulis*. The siphonal tentacles of the common cockle are sensory structures, and some bear eyes and curious sense organs situated at the bases of ectodermal depressions. These "hair sense organs" occur on ocular tentacles, but may be on eyeless ones; in the former case the same nerve supplies both. These cells are club-shaped, but do not possess stiff hairs which project to the exterior. They give off fibrils which enclose the bases of the cells of the pit which themselves bear sensory hairs. This organ is probably connected with chemical sense.

**Royal Microscopical Society (Industrial Applications Section), February 25.**—The microscope in the textile industries. F. Summers: The microscope in cotton research. Two main lines of activity can be distinguished. (1) The morphological structure of the raw cotton hair itself is the object of investigation both in the natural condition and also after modification of its structure and properties by the action of chemical substances, as in various trade processes, such as mercerisation. (2) The search for the causes of the many defects—popularly known as faults—in cotton yarns and fabrics, which may be due to the presence of abnormal hairs in the raw material or to irregularities introduced during the various spinning, manufacturing, or finishing processes. The action of mildew upon cotton at every stage of manufacture is also productive of many defects, causing discolorations or, at times, actual decomposition. The study of methods for the prevention of mildew growth on cotton goods forms one of the main features of the botanical research.—T. B. Bright: Methods of examination of mildewed cotton material. In the majority of cases mildew is easily diagnosed, but occasionally, though the damage is considerable, there is very little fungus growth, and careful examination under the microscope is necessary.

**Physical Society, February 27.**—J. J. Manley: Notes concerning the Sprengel pump. The walls of the pump are freed from gas skins by electric means, and the shattering of the mercury pellets (which tends to liberate gas) is checked by a special construction of the fall tube.—J. Young: The Thomson effect in copper, iron, and carbon steels. The apparatus described by Nettleton in the Proceedings of the Physical Society, April 1922, has been employed. Different results were obtained according as the electric current in the wire under test flowed with or against the temperature gradient.—D. W. Dye: An improved cathode-ray tube method for the harmonic comparison of frequencies and for the delineation of their wave form. Convenient arrangements for the superposition of a telephonic and a radio-frequency displacement of the light spot of a cathode-ray tube are described. The arrangements include the following: (1) Circular or elliptical trace at a telephonic frequency to serve as a time axis; (2) radial, circular, and straight-line displacements at low radio or high audio-frequencies superposed on the circular or elliptical time trace; (3) the superposition of a long narrow elliptical time displacement and a straight-line high-frequency displacement in a direction at right angles to the major axis of the ellipse. By this means a considerable portion of the time ellipse is nearly a straight line representing a uniform time axis. The wave shape at the high

frequency then appears in normal form, and may be made of quite considerable size. When an oscillatory valve system is arranged with grid and anode circuits closely coupled and harmonically resonant to each other, wave forms consisting of a fundamental and a resonant single harmonic can be produced.

**Linnean Society, March 5.**—G. C. Robson: Seriation and asymmetry in the cephalopod radula. The central tooth of the radula of many Octopoda exhibits a peculiar growth-phenomenon unique among the Mollusca. In the radula of *Octopus vulgaris*, for example, the ectocones in successive teeth occupy a progressively more external position, the migration from an internal to an external position usually occupying five teeth, after which a fresh ectocone appears and migrates outwards. This seriation is regularly asymmetrical. The asymmetry is possibly adaptational.—K. H. Barnard: A revision of the family Anthuridae (Crustacea, Isopoda), with remarks on certain morphological peculiarities. Twenty-four genera are recognised, of which seven are new. Sixty-six species are diagnosed, of which twenty-one are described for the first time. Particular attention is given to the occurrence of paired and unpaired statocysts and to the arrangement of the parts forming the tail-fan.—E. Marsden Jones: The pollination of *Primula vulgaris*. Fifteen species of insects were seen visiting the flowers. Of these, six have a proboscis long enough to pollinate satisfactorily and appear to be adequate to effect pollination. *Bombus* especially was found visiting consistently and almost exclusively the primrose. No night visitors were seen. The plants examined showed a good record of seed production, while two plants under control, a long and a short styled form, failed to produce a single capsule. It therefore seems that insect agency is necessary to secure pollination.

#### EDINBURGH.

**Royal Society, March 9.**—A. H. R. Goldie: Discontinuities in the atmosphere. The origin of "inversions" of temperature and discontinuities of motion in the atmosphere, and the dynamics of waves at a surface of discontinuity, are discussed; events are supposed to take place under adiabatic conditions. It is suggested that continuous ground level records may provide a means of estimating upper air structure. The effects of rotation of the earth on the wave motions are dealt with mathematically, and the results are in fair agreement with actual values taken from autographic records.—A. P. Laurie: Stone decay and preservation of buildings. The principal cause of rapid decay of stone is the crystallisation of calcium sulphate within the stone. The pollution of air by sulphur dioxide extends to remote regions in the country, and in the case of silicious sandstones, pollution of the stone with lime dissolved out of the mortar or cement acts as a trap for the sulphur acids. Anything in the nature of a skin over the surface of the stone like cement or plaster of Paris acts like an osmotic diaphragm, allowing free evaporation of water but causing a crystallisation pressure within the stone. Thus the length of life of limestone buildings will probably be increased by periodical washing in the summer. Stones should be selected for their resistance to acid attack and the rapidity with which they absorb and lose water.—W. H. Watson: An investigation of the absorption of supposed X-radiations. Two beams of X-rays transmitted in different directions through aluminium do not suffer any change in absorption as a result of superposition. This holds when both beams experience the J transformation by transmission. No

information could be obtained for the case where only one beam is so transformed. The incidence of a hard primary beam on silver which is absorbing a beam of the characteristic radiation of K series of that element does not influence the absorption of the latter beam in the manner expected in terms of C. T. R. Wilson's conclusions from  $\beta$ -ray photographs.—H. S. Allen: Note on Whittaker's quantum mechanism.—H. W. Turnbull and J. Williamson: The minimum system of two quadratic forms. A strictly irreducible system of projective invariants of two quadratics and any number of linear forms consists of  $3n+1$  members, where  $n$  is the number of homogeneous variables involved. The number of algebraically independent invariants is  $3n$ .—Marion C. Gray: The equation of the conduction of heat. The problem of the conduction of heat depends on the solution of a second order partial differential equation of parabolic type. Various general solutions of this equation have been given, notably by Fourier, Forsyth, and Poincaré. The apparently different general solutions can be derived from one another.

#### PARIS.

**Academy of Sciences, February 23.**—Ch. Moureu: The destruction of the original calorimetric bomb of Berthelot. Its replacement by a bomb of a new type.—Georges Giraud: The generalised problem of Dirichlet; non-linear equations with  $m$  variables.—Gaston Julia: Series of rational fractions of iteration.—N. Abramso: The curves of convergence of series proceeding according to the inverse of given polynomials.—Léon Pomey: The theorem of the existence of solutions of linear partial integro-differential equations.—Georges Valiron: An integral function of zero order which is a solution of an algebraic differential equation.—Jarry-Desloges: Contribution to the study of the phenomena of the surface of the moon.—Ferrier and L. Besnerais: A new law of electromagnetism. Admitting that two electrified particles exert on each other actions of equal and opposite magnitude  $dW/dr$  with  $W = e^2 F(u, \dots)/r$ , it is possible to conceive the existence of an electric ether constituted uniquely by particles of the same sign. This formula can interpret, not only the known phenomena of electromagnetism, but also certain hitherto unexplained facts in the field of radioactivity.—B. Szilard: A method of comparison permitting the measurement of extremely small currents. A detailed description, with diagram, of a method of measuring very small ionisation currents of the order of 1 U.E.S. with an absolute error of  $1/10^5$  U.E.S. unit.—François Liana: The transparency of glasses in the infra-red. Fifteen kinds of glass have been studied in the infra-red spectrograph of Moll. For a thickness of 15 mm. and for radiations of wave-length higher than  $3.2\mu$ , all the glasses were found to be practically opaque. The glass which has been found the best as regards transparency and dispersion is the flint D/262.—Nicolas Perrakis: Trouton's quotient at the absolute zero of temperature. Trouton's ratio tends to a finite limit as the temperature approaches the absolute zero.—Francis Perrin: The theory of polarised fluorescence. The influence of the viscosity.—Fred Viès: The spectrophotometric measurement of  $P_a$ . A formula is derived by means of which the hydrogen ion concentration can be obtained as a function of the ratio of the absorptions, independently of the concentration of the indicator and without a preliminary empirical standardisation.—G. Athanasiu: The sensibility of actinometers with mercury electrodes.—A. Wahl and Th. Faivret: The derivatives of methyl-7-isatin.—Jovan Cvijic: Morphological types of calcareous strata.—Jean Lugeon: The relations

between various meteorological discontinuities and the atmospherics in the neighbourhood of mountain chains. Atmospherics differ considerably on the plain, in valleys, and on high mountains. There appears to be a direct relation between the electrical state and the weather present over the whole of the Alps and the Jura.—L. Petitjean: A stationary discontinuity in the western Mediterranean.—H. Colin and A. Grandsire: The structure and chemical processes in the beet-root.—Henri Jean Frossard: The production of the voice.—H. Violle and L. de Saint-Rat: The hæmostatic properties of pectin.—Ed. Bayle and René Fabre: Study of the urinary elimination of alkaloids derived from isoquinoline and especially hydrastine. A small proportion, about 3 per cent., of the hydrastine absorbed is eliminated with the urine.—E. Fauré-Fremiet and Boris Ephrussi: The action of temperature on the movement of translation of *Arcella vulgaris*.—Robert Weil: The skeletonisation of the nematocysts of the Coelenterata.—Maurice Piettre: A new process of metabolism of the reserve fats. Butyrisation outside the breast.—E. Marchoux: The action of arsenic on the malaria due to *P. vivax*: Stovarsol (acetylaminophenylarsenic acid) administered either by the mouth or by injection has a rapid action on *P. vivax*, causing its disappearance, but *P. malariae* and *P. falciparum* are unaffected by this drug. This is evidence against the view that there is only a single parasite, capable of undergoing morphological and biological variations according to circumstances.

## SYDNEY.

Royal Society of New South Wales, December 3.—Griffith Taylor and F. Jardine: Kamilaroi and white; a study of racial mixture in New South Wales. The work was carried out chiefly upon aboriginals of the Kamilaroi tribe and their hybrids with the whites. The tribe occupies the central-north New South Wales. Fifty individuals were measured and details of their castes, hair, eyes, skin colour, etc., were obtained. 19 full-bloods, 7 three-quarter-castes, and 6 half-castes are discussed among the adults, and about a dozen children. The variation of cephalic index with influx of white blood is not noteworthy and does not appear in the frequency curves. The face index, however, shows a broadening in this respect. The nasal index frequency curves indicate influx of white blood very clearly, the half-castes being much more leptorhine. The hair is wavy to curly among the full-bloods, *i.e.* not very different from the hair of white folk. True curly hair was only noticed once. The eyes are usually muddy brown, sometimes with a narrow, slate-blue margin. The skin colour (under arm) is rarely chocolate, usually red-brown in the full-blood men, and Indian red in the women. It changes fairly regularly through yellow-brown to ochre with larger proportions of white blood.—R. H. Cambage: Acacia seedlings, Pt. X. Seeds of *Acacia podalyriæfolia* and *A. melanoxylon* have germinated after having been immersed in sea-water for five and seven and a half years respectively, the latter case being regarded as a record for the experiment. Certain of the species of Acacia which flower in mid-summer take about one year to ripen their pods, while those flowering in the very early spring commonly have mature pods in four or five months.—A. R. Penfold: The essential oil of *Boronia saffordiana*. This recently named species of pinnate leaf Boronia grows in the swampy portions of the heath country around Broadwater, Richmond River, N.S.W. The leaves and terminal branchlets yielded 1.45 per cent. of a pale yellow oil heavier than water, highly refracting, and possessing an odour of its principal con-

stituent, safrol, which was present to the extent of 70-75 per cent. The other constituents are d- $\alpha$ -pinene, methyl eugenol, with minor quantities of a phenol and paraffin. The oil possessed the following constants: Specific gravity, 15/15° C., 1.034, optical rotation, +3.79°, refractive index, 20° C., 1.5180.—F. R. Morrison: A chemical examination of the seeds of the "Bunya Bunya" (*Araucaria Bidwilli*) Part I. The tree is one of the Queensland pines, and bears annually cones containing more than 100 seeds. The kernel constitutes 77 per cent. of the seed. The composition of the air-dried powdered kernel was determined as follows: Fat 2.6 per cent., dextrin 7.72 per cent., starch 65.83 per cent., crude fibre 7.93 per cent., moisture 13.82 per cent., ash 2.1 per cent. Microscopically, the starch resembles rice or maize starch.—M. B. Welch: A further contribution to the knowledge of the silky oaks. The anatomical structure of a number of timbers belonging to the natural order Proteaceæ, and often known as silky oaks, was described. The woods are characterised principally by their large multiseriate rays.—W. R. Browne: Notes on the petrology of the Prospect intrusion. The mode of occurrence of analcite and other zeolites in the intrusion as well as chlorite, serpentine, and calcite, is discussed, and reasons are given for regarding them as due to late-magmatic or deuteric processes. The rock composing the intrusion should be called an olivine-analcite-dolerite rather than an essexite.

## MELBOURNE.

Royal Society of Victoria, December 11.—T. H. Laby and Miss Nelson: The thermal conductivity of gases: a contribution to the International Critical Tables. A description is given of the method by which the values of the conductivity contained in the tables are arrived at from the determinations available. A weighted mean is taken. For air the results of different observers are so weighted that equal weight is given to the methods—cooling thermometer, hot wire, and plate method—which have been used to determine the conductivity of gases. The temperature variation of conductivity of a number of gases is expressed by means of Sutherland's formula.—T. H. Laby and E. O. Hercus: Experiments on the mechanical equivalent of heat made with the apparatus described in NATURE, June 30, 1923. The value of the 20° C. calorie is higher than the usually accepted value  $4.180$  (or  $4.181$ )  $\times 10^7$  erg. A recalculation of the indirect electrical experiments of Callendar and Barnes, Griffiths, Jaeger and Steinwehr, allowing for the departure of the electrical units used by these observers from their probable C.G.S. values, gives a mean of  $4.183 \times 10^7$  erg per 20° calorie.—W. J. Young and J. R. Vickery: The changes which take place during the freezing of beef for export. Alterations in the microscopic structure produced by freezing at three different rates were compared by cutting sections while the meat was still frozen, and examining under the microscope in a room well below the freezing point. The freezing methods used were liquid air, brine at -15° C., and air at -15° C., the times of freezing being almost instantaneous, 2.5 and 15 hours respectively. The section frozen in liquid air presented a homogeneous granular appearance; the other two contained large crystals of ice between the muscle fibres, many of the latter being twisted and broken in the process. The difference was much more marked in the sample frozen most slowly. The changes occurring in the refrigeration of beef occur in the actual freezing.—Miss Kerr: The symbiosis of *Loranthus* and *Eucalyptus*. For a time at least a

Eucalyptus stock which has no foliage of its own can be nourished by a parasitic Loranthus, *i.e.* that a relationship may be established analogous to that between the stock and scion in a grafted plant. The injurious effect upon the host plant is due to the excessive transpiration rate of the parasite, which causes the host plant to suffer from lack of water, particularly during dry periods.—G. F. Hill: Termites from the Australian region: descriptions of new species and hitherto undescribed castes. Eight species are proposed as new, including two species of Eutermes from W. Australia and one species each from N. Queensland and N. Territory, one species of Calotermes each from Victoria and N. Territory, and two from Lord Howe Island. The alate imagos of two species of W. Australian Eutermes, hitherto known in the sterile castes only, and the soldier caste of two species of Calotermes (from Victoria and W. Australia respectively), hitherto known in the alate form only, are described for the first time. One of the latter, *C. obscurus* (Walker), until recently known only from the badly-damaged type and a very inadequate description, has been re-discovered in the type locality and fully described. A new name (*C. rufinotum*) is proposed for the Victorian species previously described in detail and provisionally referred to the last-mentioned species by the writer.—J. A. Smith: The graduation of the circle. Early graduations by hand, and the ingenious steps in the evolution of the "graduating engine" were outlined. The design and construction of modern machines such as the Swasey were described. The attainable precision is of the order of a maximum deviation of one-tenth of an inch at one mile.

## VIENNA.

Academy of Sciences, February 5.—Scientific results of the expedition to the Anglo-Egyptian Sudan (Kordofan) undertaken by F. Werner in the year 1914. XXI.—I. Sjöstedt: Isoptera, reporting two new kinds of termites, with an appendix by R. Ebner on termite buildings. XXII.—W. Adensamer: Mollusca, including those of the Blue Nile.—H. Pettersson: Communication from the Radium Institute, No. 176. Theory of the method of atomic disintegration. A simple arrangement is described which enables the H-particles and reflected  $\alpha$ -particles from disintegrated elements to be observed when weak radium C or thorium C preparations are used. The use of this arrangement for observing the number of H-particles emitted simultaneously by a disintegrated nucleus is shown by a series of measurements with aluminium.—H. Handel-Mazzetti: Plantæ novæ Sinenses. Thirty-second contribution, including three new species of Lysimachia.—A. Köhler: The granulite and granulitegneiss problem in the south-western forest quarter of Lower Austria near Säusenstein, Wieselburg and Melk.—O. Wettstein: A new species of mouse from Lower Austria.—R. Andreasch: On carbamide and guanine derivatives of the sulpho-fatty acids.—O. Lehmann: The geographical results of Dr. H. Handel-Mazzetti's journey through Guidschau (Kweitschou) in South-Western China.

## Official Publications Received.

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 32: A Study of 260 School Consolidations. By J. F. Abel. Pp. iv+89. 10 cents. Bulletin, 1924, No. 29: Legislation on the Junior High School. By Paul W. Terry and William J. Marquis. Pp. iii+42. 10 cents. Bulletin, 1925, No. 1: Educational Directory, 1925. Pp. iii+201. 25 cents. Bulletin, 1924, No. 28: Fiscal Support of State Universities and State Colleges. By Dr. Clarence Howe Thurber. Pp. iv+164. 20 cents. Bulletin, 1924, No. 36: A Manual of Educational Legislation, for the Guidance of Committees on Education in the State Legislatures. Pp. iii+51. 10 cents. (Washington: Government Printing Office.)

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, the Physiological Chemist, and the Secretary, Sugar Bureau), 1923-24. Pp. iv+141. (Calcutta: Government of India Central Publication Branch.) 1 rupee; 1s. 8d.

Report of the Department of Mines for the Fiscal Year ending March 31, 1924. Pp. iii+71. (Ottawa: F. A. Acland.) 15 cents.

Canada. Department of Mines: Geological Survey. Memoir 142, No. 123 Geological Series: Preliminary Report on the Clay and Shale Deposits of Ontario. By J. Keele. Pp. iii+176+9 plates. 25 cents. Summary Report, 1923, Part B. Pp. 115B. Summary Report, 1923, Part C1. Pp. 168C1. Summary Report, 1923, Part C2. Pp. 44C2. (Ottawa: F. A. Acland.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 14. Spectroscopic Evidence of Isotopy. By H. Nagaoka, Y. Sugura and T. Mishima. Pp. 112. 1 yen. No. 15: The Results of the Analyses of the Soils and the Ashes of some Sugar Cane. By I. Wada, S. Ato and S. Kato. Pp. 113-124. 20 sen. No. 16: Application of X-ray Diffraction to the Determination of the Crystal Structure of the Iron-Steel. By G. Asahara. Pp. 125-137+1 plate. No. 17: The Stark Effect of Electric Field in Metal Arcs and the Stark Effect observed in Arcs of Silver, Copper, Magnesium, Chromium, Nickel, Cobalt, Iron and ten other Metals. By H. Nagaoka and Y. Sugura. Pp. 139-167+plates 3-17. 250 sen. No. 18: Spectrum of Mercury under heavy Current Excitation. By M. Fukuda. Pp. 169-183+plates 18-20. 60 sen. (Komagome, Hongo, Tokyo.)

Conseil Permanent International pour l'Exploration de la Mer. Publications de Circonstance, No. 85: Observations on the Witch (*Neuroneutes cynoglossus* L.) and its Growth. By Arvid R. Molander. Pp. 15. (Copenhagen: Andr. Fred. Hest et fils.)

The National Physical Laboratory. Report for the Year 1924. (Published for the Department of Scientific and Industrial Research.) Pp. 221. (London: H. M. Stationery Office.) 8s. 6d. net.

British Research Association for the Woollen and Worsted Industries. Annual Report, 1924. Pp. 19. (Headingley, Leeds.)

Proceedings of the University of Durham Philosophical Society. Vol. 7, Part I, 1923-1924. Pp. 58. (Newcastle-on-Tyne.) 5s.

University Ideals. The Presidential Address to the Yorkshire Natural Science Association, Session 1924-25. Genetics and Wool Production: an Address to the Pan-Pacific Science Congress held at Sydney University, August 1923. By Prof. Aldred F. Barker. Pp. iv+60. (Leeds.) 3s.

## Diary of Societies.

## TUESDAY, APRIL 14.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough College, Loughborough) at 6.45.—A. B. Mallinson and G. H. D. Smith: The Sea Power Plants.

## WEDNESDAY, APRIL 15.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Graduates Meeting) (at Chamber of Commerce, Birmingham) at 7.30.—A. Weatherstone: High-speed Motor-cycle Engine Valve Gears.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield) at 7.30.—Dr. F. S. Goucher: The Strength of Metals under Impact.

## THURSDAY, APRIL 16.

INSTITUTE OF CHEMISTRY (Belfast Section) (at the Queen's University, Belfast), at 7.30.—Prof. Symmers: Address.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers), at 7.30.—C. H. M. Jenkins: Metals in the Gaseous State.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—J. Guild: The Geometrical Solution of Colour Mixture Problems.—Peeling and Van Neck: Exhibition and Description of The Hahn-Goerz Workshop Microscope; The "Artisat" Mirror Arc Lamp.

## FRIDAY, APRIL 17.

DIESEL ENGINE USERS' ASSOCIATION (at Engineers' Club, Coventry Street, W.1), at 8.30.—J. L. Chaloner: Recent Oil-engine Developments.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—Dr. H. D'Arcy Power: The Reproduction of Colour and Tone.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. T. Dunn: Vertical Rotors.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle Graduate Section) (at Cleveland Scientific and Technical Institute, Middlesbrough), at 7.30.—Question Night.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Sir Henry Gauvain: The Use of the Light of a Light Department in a Surgical Theatre. By J. G. Murray Levick: The Selection of Apparatus for the Production of Artificial Sunlight.—Prof. Russ and Dr. Peacock: Ultra-violet Radiation.

## SATURDAY, APRIL 18.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at Municipal College of Technology, Manchester), at 7.—A. Hill: Foundry Materials.

BOLTON AND DISTRICT MANAGERS' AND OVERLOOKERS' ASSOCIATION (at the Institute, Henry Street, Bolton), at 7.30.—B. Robinson: Education and Industry.



SATURDAY, APRIL 13, 1925.

## CONTENTS.

	PAGE
The Universities and International Relations . . . . .	557
Recent Atomic Theory. By R. H. Fowler . . . . .	559
Science for the Public . . . . .	561
A Great Physician. By A. S. M. . . . .	562
Our Bookshelf . . . . .	564
Letters to the Editor :	
The Effect of the Earth's Rotation on the Velocity of Light.—Prof. A. A. Michelson, For. Mem. R.S., and Prof. Henry G. Gale . . . . .	566
Atmospheric Electric Transmission.—Sir Joseph Larmor, F.R.S. . . . .	566
Diffusion of Momentum by Air Currents.—A. Mallock, F.R.S. . . . .	567
A Course of Faraday.—Prof. Henry E. Armstrong, F.R.S. . . . .	568
Some Notes on the Taungs Skull.—Dr. R. Broom, F.R.S. . . . .	569
The Skull of Robert the Bruce.—Prof. Karl Pearson, F.R.S.; Sir Arthur Keith, F.R.S. . . . .	571
A Peculiarity of some Red Neon Lines —W. H. J. Childs . . . . .	572
The Fate of the Cyst of Monocystis in the Avian Gut.—Vladimir Ignatieff . . . . .	572
The Dinosaur Region in Tanganyika Territory. By C. W. Hobley, C.M.G. . . . .	573
Sex-Determination. By Dr. F. A. E. Crew . . . . .	574
Obituary :—	
Prof. James Ward. By Prof. G. Dawes Hicks . . . . .	577
Current Topics and Events . . . . .	579
Our Astronomical Column . . . . .	582
Research Items . . . . .	583
The Fifth Washington Meeting of the American Association for the Advancement of Science . . . . .	586
Innermost Asia: its Geography as a Factor in History . . . . .	588
University and Educational Intelligence . . . . .	588
Early Science at Oxford . . . . .	589
Societies and Academies . . . . .	589
Official Publications Received . . . . .	591
Diary of Societies . . . . .	591

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The Universities and International Relations.<sup>1</sup>

IN the United States, the Government takes no part in the promotion of international interchanges of students and teachers, except in a negative sense—through the application of the laws restricting the immigration of aliens; but several powerful corporations do very energetically encourage such interchanges. The activities of the American University Union in Europe (London and Paris) and the American Council on Education, in which the Union is now merged, are well known. The Council's *Educational Record* of April gives particulars of 76 American organisations in the field of international educational relations. One of these, the Institute of International Education, founded in 1919, administers a large number of scholarships for students of various nationalities, makes grants for expenses of foreign travel to American professors on leave of absence, publishes guide-books for foreign students in the United States and for American students in foreign countries, holds educational conferences, and serves as a clearing-house for information relating to international education. It has, moreover, fostered the formation of clubs for the discussion of international relations in American universities.

The Rockefeller Foundation devotes vast sums to the endowment, largely by means of international fellowships and grants to foreign universities, of study and research in medicine and hygiene. "International House," opened in 1924 in New York as a residential club to accommodate 500 students from all parts of the world, was built by Mr. J. D. Rockefeller, Jun. This philanthropist founded in 1923 an "International Education Board," which has established the International Institute of Teachers College, Columbia University, and endowed it with an annual grant of 100,000 dollars a year for ten years. The work of this institute comprises the exposition of American ideals and institutions as a basis for understanding American education, instruction in American systems of pedagogy and their adaptation to foreign situations and problems, and visitation of American schools. In 1923, some 250 foreign students were availing themselves of these facilities for "becoming intellectual subjects" of America, and there were also in attendance 100 Americans who held posts as teachers in other countries. Other appropriations of the International Education Board, amounting in all, up to June 30, 1924, to more than six hundred thousand dollars, include 60 science fellowships for workers in 17 countries.

In 1921 the number of foreign students in United States colleges and universities was 8357. In the same

<sup>1</sup> Continued from p. 523.

year, the universities of Germany, which, before the War, had more than those of any other country, had 6334. This, considering the troubled condition of the country, is a surprisingly large figure. The close relations formerly existing between German and American universities have not yet been restored, but steps in this direction have been taken. The International Institute of the University of Heidelberg for the study of English and American institutions has on its advisory council eleven eminent representatives, including several presidents, of American universities; it invited the Director of the Institute of International Education to be the council's chairman.

The American Commission for Relief in Belgium was responsible for founding in 1920 the Fondation Universitaire in Brussels with a capital of 55 million francs. This foundation, in addition to its other activities, makes grants for study in American universities to Belgian graduates and vice versa, and arranges exchange visits of professors. The American-Scandinavian Foundation provides 40 travelling fellowships of a thousand dollars each for travel and study by American graduates in Scandinavian universities and vice versa. In Spain, the oversight and direction of all matters relating to State scholarships tenable abroad, exchanges of teachers and students, bursaries in connexion therewith, and courses for foreign students, are entrusted to the Junta para Ampliación de Estudios e Investigaciones Científicas. This body has established a Spanish Institute in New York, which is housed in the offices of the Institute of International Education.

In Great Britain and Ireland the international interchange of university students and teachers is encouraged neither by the State as in France, Italy, and Spain, nor, with the exception of the Rhodes Scholarship Trust, by great corporations as in the United States. There are, however, a number of travelling fellowships and scholarships established in connexion with some of the universities, and since 1922 the National Union of Students of the universities and university colleges of England and Wales has been active in promoting foreign travel of English students and their intercourse with students abroad.

It is sometimes assumed that international interchange of students must necessarily tend to promote international amity through dissipating prejudices and misconceptions, but it is by no means always the case that the impress on the mind of the university student of the contacts he makes when sojourning in a foreign university has this desirable tendency. The same may be said of the impressions produced by university students and teachers visiting foreign institutions. Quality is all-important, and measures undertaken for the indiscriminate multiplication of interchanges may

do much harm to the cause their authors wish to promote. This principle was fully recognised in the framing of the Rhodes scholarships scheme and its new American counterparts, and it should never be lost sight of by those whose duty it is to award scholarships tenable in foreign countries.

It is, on the other hand, important that the visitors should have sufficient opportunities of participating fully in the social as well as the academic life of the university. To those who fulfil its matriculation requirements, the university opens its doors and thenceforward treats them all alike without respect to race, creed, or nationality. The ordinary matriculation requirements are, moreover, relaxed in favour of students who, having been educated abroad, are not prepared to pass the ordinary English matriculation examinations, but have qualified for admission to a foreign university. For the university to show still further solicitude for the interests of foreign students as such by making special provision for their social well-being would be inappropriate and liable to misconstruction. Their special needs, however, have been made the subject of sympathetic consideration by several bodies not officially connected with the universities, notably the Student Christian Movement, the National Union of Students, and the League of Nations Union.

In relation to such matters as the provision of opportunities for social intercourse, obtaining suitable accommodation in term and during vacations, the help afforded to foreign students by these bodies is of great value. Discussions promoted by the National Union of Students have stimulated among student bodies an increasing interest in international relations: an interest which has led to the formation of "Hospitality Committees," which have invited parties of about half-a-dozen students of universities in Germany, France, Czecho-Slovakia, Denmark, and Norway to visit English universities during term. As a rule, one party is invited each term. On arrival the visitors become the guests of English student organisations, thus being saved all expense of board and lodging, and are given an intimate view of English life in the universities; in some cases even railway travelling expenses have been borne by hosts. The period of stay in each university varies from three to ten days. Universities that have already entertained in this way are Cambridge, Oxford, London, Liverpool, Birmingham, and Leeds. To some extent these visits are of a reciprocal character, student bodies in foreign universities offering similar hospitality to parties of English students, but there is nothing in the shape of bartering in connexion with them, the invitations being in every instance free, unconditional, and spontaneous, and actuated by a desire to promote good feeling between the nations.

Finally, mention must be made of certain organisations which are international not only in their activity, like the bodies already mentioned, but also in their constitution: The Committee on Intellectual Co-operation of the League of Nations, with its University Information Office; the Confédération Internationale des Étudiants, formed at Strasbourg in 1919; the International Federation of University Women, founded in 1920; and the World's Student Christian Federation. All these in different ways work for international harmony through improved mutual understanding, and cultivate a certain detachment from the national point of view and a spirit of mutual toleration, which are indispensable preliminaries for co-operation. Education is, no doubt, a peculiarly favourable field for international co-operation in certain conditions; for example, there is now a valuable opportunity for co-operation between Great Britain and China; but to what extent internationally constituted bodies are suitable instruments for organising such co-operation is doubtful. Owing to the diversity of their constituents, they are likely to be less effective in some respects than national bodies such as the American Institute of International Education.

### Recent Atomic Theory.

- (1) *The Theory of Spectra and Atomic Constitution: Three Essays.* By Prof. Niels Bohr. Second edition. Pp. x+138. (Cambridge: At the University Press, 1924.) 7s. 6d. net.
- (2) *Vorlesungen über Atommechanik.* Von Prof. Dr. Max Born. Herausgegeben unter Mitwirkung von Dr. Friedrich Hund. (Struktur der Materie in Einzeldarstellungen, 2.) Erster Band. Pp. ix+358. (Berlin: Julius Springer, 1925.) 15 gold marks.
- (3) *Zeemaneffekt und Multiplettstruktur der Spektrallinien.* Von Dr. E. Back und Prof. Dr. A. Landé. (Struktur der Materie in Einzeldarstellungen, 1.) Pp. xii+213+2 Tafeln. (Berlin: Julius Springer, 1925.) 14.40 gold marks.

THE structure of the atom will be generally admitted to provide the most fruitful and important field of work in modern physics, but even so it can be but rarely necessary to welcome simultaneously three books of such importance dealing with this one subject. Let us extend to the three at once the warmest possible welcome, and proceed to consider separately their individual contents, and the light that they throw on the recent trend of speculation in atomic theory.

(1) It is convenient to consider first the reprint of Prof. Bohr's three essays, to which, in this edition, an

appendix has been added describing shortly later developments which correct and amplify certain earlier statements, particularly in the third essay. The theme of this whole book may be called the "central orbit" theory of the atom, originated by Prof. Bohr, and developed largely by Prof. Sommerfeld and himself. The theory sets out to co-ordinate the main features of atomic structure, spectra, and other properties on the basis of a classification of the orbits of the electrons in the atom into groups, specified by the two quantum numbers  $n$  and  $k$ , which must characterise any orbit in a conservative central field of force, not obeying the law of the inverse square. Purely electrostatic forces must still give rise, by a screening effect, to such deviations from the inverse square. The success of this theory is now a commonplace. The development of any significant theory consists of two parts of equal importance—the determination of the field of facts which the theory can successfully correlate, and the determination of the field of facts which, by their very nature, must lie outside the domain of the theory. In the case of the central orbit theory, as these essays and their appendix now make abundantly clear, these domains are already well defined. The dividing line lies at that point at which it is necessary to introduce a third quantum number to account for optical and X-ray ("relativistic") doublets. Questions such as these are essentially connected with the interactions between one electron and others in an atom. Bound up with them are all the questions connected with the closing of electronic groups and sub-groups, the numbers of electrons in these groups, chemical combinations (other than of ionic type), and the insistent manifestations of half-quantum numbers. These matters lie necessarily outside the domain of the central orbit theory, and the modification of theory necessary to meet them is not yet clear. It is clear only that it must be fundamental.

Great progress has already been made in this wider domain, thanks largely to the study of the Zeeman effect and its partial but strikingly successful interpretation in terms of a magnetically coupled system of core and series electron. But this is not enough. These, however, are matters deliberately excluded from Prof. Bohr's book, for which we may naturally turn to Profs. Back and Landé. In the field proper to the central orbit theory, its success has been singularly rapid and complete. Quantum numbers  $n$  and  $k$  can be specified with certainty for all electronic groups and all (or nearly all) X-ray and optical terms (in the simpler spectra), and the general features and properties of the atom are convincingly represented. There remain only many interesting points of detail, especially in the assignment of quantum numbers for certain optical

terms; but these may, of course, prove to be of unexpected theoretical significance.

If this interpretation of the situation is correct, and we may write *Finis* to the central orbit theory, a superficial feeling of disappointment is perhaps inevitable, but still more certainly unjust. Every valuable theory in process of development must raise hopes that are naturally extravagant. We have only to contemplate for a moment the successes of the theory, and the beautiful correlations it has introduced into such a wide range of physical and chemical properties—to read once again Prof. Bohr's book—to lose all feelings of disappointment, and rest convinced that the theory, like the nuclear theory from which it springs, will remain a fundamental link in the chain of physical science.

(2) The other two books to be noticed here are the first two volumes of a series of monographs, of which the general title is "Die Struktur der Materie," and the general editors Profs. Born and Franck, of Göttingen. The field of atomic physics is being developed at such a pace in so many directions that it is scarcely possible any longer to cover the whole ground in a single treatise. The outstanding attempt so to cover the ground is Prof. Sommerfeld's monumental book. This has grown from 570 to 860 pages in four editions. Even so it cannot discuss fully many important questions. While it remains perhaps the best general introduction to the whole subject, detailed presentations of separate branches, in particular of the mathematical foundations, are also required, and it is to provide these that the present series has been started. The need is admittedly urgent and these two volumes are worthy of the occasion. Let us hope that they will be speedily followed by worthy successors.

Prof. Born's book on atom mechanics is a book for which there has been a peculiarly urgent need, for it should provide just that introduction to atomic theory which a mathematical student requires, presented in the mathematical form which he will most appreciate. There is no such book in English, or, previously, in any other language; one may venture to hope that it will be shortly published in an English translation, for unless some similar book is written in English, Prof. Born's should be freely used by students to many of whom the language must prove a difficulty. The matter presented in this book is the mathematical structure of the present form of the quantum theory and its applications. It may fairly be described as an almost ideal mathematical companion volume to Prof. Bohr's writings on the central orbit theory. Questions outside the field of this theory are deliberately excluded. In view of these well-defined limitations, Prof. Born calls his book "Volume 1." By this he explains that

he wishes to emphasise these limitations, and hopes to write some day in Volume 2 the next approximation to the true mechanics of the atom.

Perhaps the best part of the book is Chaps. i. and ii., which develop, with exquisite attention to the finer points, the Hamilton-Jacobi theory and the formal quantum theory of periodic and multiply-periodic systems. The fourth and last chapter gives an account of perturbation theory, with (condensed) applications in particular to the helium problem, which it is most convenient to have in this form. It is true that the applications of the theory have been largely negative, but they have, as Prof. Born says, sufficed to show that it is not the purely analytical difficulties of the  $n$ -body problem which conceal from us the details of atomic structure, but difficulties of an entirely different order. Negative or not, this is a theoretical point of fundamental importance. The remaining Chapt., iii., is entitled "Systems with One Series Electron." It might with advantage have been divided into two chapters, one on the general theory of the hydrogen-like atom, the other on the series formula of Rydberg and Ritz. The section on the hydrogen atom gives a systematic account of all the theoretical work on this atom, in which the modern formulation of the quantum conditions and the requirements of the correspondence principle are kept constantly in view. Systematic applications of the theory of secular perturbations are made at every stage. One is particularly thankful to find here an easily followed exposition of the difficult problem of the crossed electric and magnetic fields, after the elegant method of Lenz and Klein.

The remaining section on the Rydberg-Ritz formula is an important part of the book, for the theory of this formula is one of the great successes of the present theory, and, in a sense, the basis of Prof. Bohr's general scheme of atomic structure. The account here given is different in viewpoint to that of Prof. Sommerfeld (Ed. 4), being deliberately more theoretical. It contains, too, the first published proof of Prof. Bohr's general theorem on the Rydberg-Ritz formula [When will Prof. Bohr publish his own still more elegant account?], and an account of Prof. Born's own work with Heisenberg on the polarisability of the core. It culminates in an account of the determination of the principal quantum numbers of optical terms, leading on to a general survey of the periodic system. It must be admitted that it is possible to criticise this section on points of detail, but the theory is here least fully formed. It forms as a whole a most valuable contribution to the literature of the subject.

(3) In the remaining book, by Profs. Back and Landé, on multiplet structure and the anomalous Zeeman effect, we pass, as we have already said, right beyond

the limits of the central orbit theory. To the theoretical exploration of this field no one has contributed more than Prof. Landé himself. It is perhaps fair to say that his (the theoretical) section of the book is scarcely a new systematic exposition of the present position of theory in this field, but rather reminiscent of a collection of reprints of his own and others' papers on these subjects. It is therefore sometimes a little hard to be sure whether a statement is to be regarded as a statement of fact, a deduction from generalised theory, or from some specialised model. This perhaps is inevitable and certainly extremely difficult to avoid at such a stage of development as the present. It is a great thing merely to have the work collected in this readily accessible form, especially the suggestive speculations on multiplet spectra of the second rank. The book should serve to stimulate further advances in this field, which will almost certainly be of dominant importance in the next development of atomic theory. The experimental (Prof. Back's) section of the book appears to a layman to be an excellent systematic account of the experimental side of the determination of anomalous Zeeman types. This is not without its special difficulties when the type is a complicated one. A septett (*df*) line may split into as many as 33 components at  $\frac{1}{10}$  the normal separation, with a very large range in intensity. These difficulties are carefully treated, and there are numbers of extremely useful tables and diagrammatic representations of types. The book ends with a plate of 35 beautiful photographs. These alone almost reconcile one to its price. R. H. FOWLER.

### Science for the Public.

*Chats on Science.* By Dr. Edwin E. Slosson. Pp. vii+253. (London: G. Bell and Sons, Ltd., 1924.) 6s. net.

*Keeping up with Science; Notes on recent Progress in the various Sciences for Unscientific Readers.* Edited by Dr. Edwin E. Slosson. Pp. xv+355+30 plates. (London: Jonathan Cape, Ltd., 1924.) 10s. 6d. net.

THE popularisation of science has been frequently discussed in the columns of NATURE, and the subject is undoubtedly arousing increased attention. In the daily press there is evidence of a desire to devote more attention to science; and some of the leading dailies endeavour to secure that what they print is really authentic. On the whole, however, the position is far from satisfactory, and in those cases where the serving up of science is left entirely to the ordinary journalist in search of stirring news, the result is often very deplorable. A newspaper that would think it discreditable to commit a solecism in dealing with any other branch of knowledge, or with

such special matters as music and painting, is often found capable of printing the most egregious paragraphs in relation to science.

The British scientific world constantly demurs to this treatment by the press, yet does little to help in bringing about a more satisfactory state of things. Certainly it is difficult to know what to do or to recommend. Some people go so far as to affirm that it is not possible to do anything at all with the physical sciences. "You can count," they say, "on no knowledge even of the most elementary kind in the minds of your newspaper readers; how can you expound new discoveries when on every occasion you have to go back to the very alphabet of science as your starting point?" The answer is, no doubt, that while very much cannot be done, something may be done, and that it is desirable for the scientific world to help in making that something as good as possible.

It is important to recognise the difference between knowing science and knowing about science, for the present-day demand, which the circumstances of our disordered world have greatly intensified, seems to be, above all, for a better knowledge about the ways of science. Scientific men are beset to-day by eager inquirers who want to know what is the real incidence of science upon thought and life, how much it can contribute to right thinking and right living, how far it embodies an element of the spiritual. How is it possible to respond at all effectively to this demand?

It is with this question in our mind that we take up with interest the two books before us from the hand of the Director of Science Service, Washington. The Science Service was founded by private enterprise in 1921. "The Institution was intended to serve as a liaison officer between scientific circles and the outlying public . . . and it has been doing what it could to spread a knowledge of scientific achievement and ideals by means of newspapers, magazines, books, and motion pictures." It has been warmly encouraged by American men of science, it has a large staff and, we understand, a thoroughly well-organised system of providing the press with trustworthy scientific news and other scientific copy in an acceptable form.

Of the books under notice, that entitled "Keeping up with Science" consists mainly of articles which have formed a fortnightly page in the *Country Gentleman*. The other book is exactly what its title states—"Chats on Science," each occupying two or three pages that can be read in as many minutes. In neither book is there any ordered sequence or continuity of topics; indeed, the design seems to aim at quick change. "If that does not interest you particularly, then read this," we seem to hear continually. As the Science Service takes all science for its province, we have in

the books before us a variety in the contents which altogether forbids description. From about a hundred and forty articles which, with forty-four excellent illustrations, occupy some 350 pages of "Keeping up with Science," the titles of the first dozen are: Science and Pseudo-science, Chemical Messengers, The Smell of the Hive, How Baby Plants know the Way Up, Man sees 6,000,000,000,000,000 Miles, Making a Camera see Farther, The Warmth of a Snow Blanket, How Arrow-heads Are Made, The Hammering of Storms, Friendly Germs, Memory Knots, Champion Flyers.

The reviewer would like to say at once that he thinks Dr. Slosson is exhibited by these books as a man of very remarkable gifts, and that he has set in action a plan of popularising science which is of the highest interest and deserving of our closest attention.

In attempting to give some account of this plan, perhaps the first thing to be said is that Dr. Slosson appears in the guise of a modern journalist. One feels, from the title of the themes, from their composition, from their form, that the writer must surely have served a long apprenticeship in the art of savouring and serving news for the multitude. In saying so much we may seem to be paying a very dubious compliment, but there is surely something good to be done with the peculiar power which the best journalists acquire of putting what they have to tell in arresting form. The journalistic guise of Dr. Slosson will, however, be quickly penetrated by men of science, and as they read they will see the real scientific prophet that it masks. They will find under the surface of his light-hearted exposition and accompanying his quips and cranks, the evidence of a very serious purpose and a deep-laid scheme of worthy propaganda and genuine enlightenment. British readers will, of course, have to remember that what is written is for the American public. It would not quite do for us as it stands, but it nevertheless suggests the type of treatment that could be used for British readers.

The chief interest is in surveying the choice of themes, in seeing what sort of points Dr. Slosson attempts to make, and in observing the selection of facts, the fragments of philosophy, the intellectual stimuli that are used in achieving his purpose.

It seems to the reviewer to be extraordinarily well done, and that Dr. Slosson and his Science Service are greatly to be congratulated on their achievement. They have taken journalistic ground, and if it is said—and no doubt it will be said—that they deal slenderly with the science they implant thereon, it cannot be regarded as less than a triumph that they are rescuing journalistic science from the hands which habitually made of it nothing but a useless travesty. They are

giving some true indication at least of the extent to which science interpenetrates the whole of our modern civilised life, and of the influence which it must inevitably have upon the greatest issues of human existence.

In one of the chats on science there are given some statistics which give a measure of the success attained. It appears that among the articles on biological science appearing during a month in fourteen prominent papers from as many different cities from Boston to Los Angeles, only a fifth of one per cent. of the matter was deemed fictitious by authorities from Teachers' College, Columbia. These same authorities declared, indeed, that—"Newspapers appear to be more up-to-date in things biological than are college and high school texts in the subject"; and in conclusion they turn tables on the teachers by advising them to make use of newspaper articles in class-room instruction in order to show that biology "is meaningful to the student." The success of Science Service in the United States, from the point of view of science as well as that of the public, makes us hope that an institution of a similar kind may be established in Great Britain. Whatever funds were provided to place such an organisation upon a sound footing would be returned many times in the form of increased attention to scientific study and support for scientific research.

### A Great Physician.

*The Life of Sir William Osler.* By Harvey Cushing. Vol. 1. Pp. xv + 685 + 20 plates. Vol. 2. Pp. xii + 728 + 21 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1925.) 37s. 6d. net.

THE awaited Life of Sir William Osler is before us. His subject "A Physician of Two Continents," the author has appropriately devoted the first volume to the Canadian and United States periods, while the second volume deals with the Oxford period. But to readers in the new world as well as the old, both volumes will appeal for the sake of Osler's great and lovable personality.

Dr. Harvey Cushing, who handles pen and scalpel with equal skill, has made Osler live again for us in these pages. He has mainly effected this by a similar method to that pursued by Lockhart in writing the Life of Scott. So far as is possible, extracts from Sir William's letters and the writings of his contemporaries are introduced to bring back the events of past days; the art of the biographer is declared in the way in which these documents fall naturally into the course of the main narrative. This indeed, as is stated in

a short foreword, has been Dr. Cushing's object, and he has not wished, for the present at all events, to appraise Osler's professional accomplishments. Most readers after perusing the book will agree that such comments would be superfluous.

William Osler was born on July 12, 1849, at Bond Head, in Upper Canada. He came of Cornish stock through both parents. His father was a clergyman, the Rev. Featherstone Lake Osler, who settled as a missionary in Canada in 1837 with his wife, Ellen Pickton, who died a centenarian. William, named after William of Orange, was the youngest son in a family of nine, nearly all of whom became distinguished in the affairs of their native country. At first destined for the church, the influence of two of his teachers, Johnson and Bovell, one a priest and school-master, first a theologian, secondly a naturalist, the other, a physician but at heart a priest, undoubtedly directed the young student's attention to medicine through the portal of natural science. Osler's studies of the Diatomaceæ and fresh-water Polyzoa led him on to Entozoa and eventually to work on blood-films in London and Montreal: to note malarial parasites at Philadelphia and the amœbæ of dysentery at Baltimore. He took his medical degree at McGill University in 1872, and then passed two years of study abroad in the course of which he worked at physiology and pathology under Burdon Sanderson, to whose future chair at Oxford in the fulness of time he was to succeed.

In the 'seventies, medicine was being again revolutionised; to every port of knowledge came argosies rich in the new learning. Giants indeed were in those days; Darwin had written "The Origin of Species"; Huxley and Burdon Sanderson were making physiology a science; Pasteur was founding bacteriology, and Lister was re-making surgery; Ferrier was discovering cerebral localisation; Paget was wedding pathology to surgery; Virchow was teaching pathology in Berlin; and Villemin's researches had paved the way for Koch's impending discovery of the tubercle bacillus. Into the harvest of science came the young Canadian doctor, a worker as well as a gleaner. He returned to Montreal in 1874 as lecturer in the new subjects of physiology and pathology at his *alma mater*.

Ten years of scientific work followed, chiefly in pure pathology, but towards the end of the Canadian period, Osler had found his life-work. In 1884 he accepted the post of professor of clinical medicine in the University of Pennsylvania, and five years later was called to Baltimore as professor of medicine in the newly established Johns Hopkins Medical School. Dr. Cushing tells in detail the story of Osler's achievements here. He built up a wonderful Medical School; he was made a fellow of the Royal Society; he wrote a text-book,

successive editions of which have been in the hands of medical students and medical practitioners throughout the world; he made it possible for the American students to study medicine in the wards by the bedside; he gained international reputation as a physician, a teacher, and a writer. At fifty-six years of age his cup overflowed with wisdom; yet fortune had more gifts in store for him, and the land of his ancestry claimed him as her own.

After refusing many calls to other positions, in 1904 he accepted the Regius professorship of medicine at Oxford. It is a chair in which one may grow old gracefully; the duties attached to the post are not onerous, and ample leisure might have been afforded for Osler's enjoyment of his library and literary pursuits.

Sir William (he received a baronetcy in 1911) was not a man to rest on his laurels. Within a short space of time his personality was felt in the ancient University, where he was soon known to the medical undergraduate as the most human of professors. He taught clinical medicine at the Radcliffe Infirmary; he proved himself a classic and a philosopher at the high tables of colleges; he and Lady Osler in their unbounded hospitality made Oxford the Mecca of every doctor and student and knit up a thousand close ties between England and America. His influence went far beyond Oxford in constant demands for lectures, addresses, committees, and consultations; he spent himself freely for the advancement of learning and the good of mankind. The aim of Osler's life is written in the preface to his text-book: "To feel that I may have been helpful in promoting sound knowledge is my greatest satisfaction." Needless to add, this feeling was amply justified. The War came and clouded his last days with irreparable sorrow, but to the end in 1919 he was the captain of his soul.

It has been stated that Osler made few contributions to science, and that his chief claim to fame rests on his unquestioned abilities as a teacher and exponent of clinical medicine. There is scant justice in this view, supported, though it may be, by Osler's modest estimation of his own work. As has been mentioned, his bent for scientific research was shown in youth when, in his paper on the Diatomaceæ, he enumerated 110 species in 31 genera collected by himself. When only twenty-four years of age, he made the fundamental investigation of blood platelets and was the first to describe these bodies in the circulating blood. In 1877 he described a form of broncho-pneumonia in dogs, due to a previously unknown parasitic nematode to which Cobbold has given the name of *Filaria Osleri*. There is little doubt that, had he continued his studies in pure pathology, he would have taken high place

both as an investigator and teacher. In many respects he was more prescient than some of his contemporaries, for he early apprehended the importance of the new pathology and made it the basis of scientific medicine. This practice is so generally accepted to-day that we are apt to forget it is in large part due to Osler; through his work and teaching the modern presentation of medicine, based on known causes with signs and symptoms explained or verified in the *post-mortem* room and in the laboratory, has emerged.

Although a sedulous compiler of the work of others, in medicine itself Osler made numerous original observations. In 1902, he described the condition of cyanosis with polycythæmia, known as Vaquez-Osler disease, and an hereditary malady characterised by multiple telangiectases associated with hæmorrhages may rightly also be styled Osler's disease. His Goulstonian lectures on malignant endocarditis, his lectures on the cerebral palsies of children, and his Lumleian lectures on angina pectoris, were based on a wealth of clinical experience and information. In addition to the work published under his own name, many important discoveries in various branches of medicine put forth by his colleagues and pupils can be ascribed to what Clifford Allbutt termed Osler's wonderful power, only possessed by a few great teachers, of "inseminating other minds."

As Dr. Cushing writes: "There were indeed many Oslers: the physician, the professor, the scholar, the author, the bibliophile, the historian, the philanthropist, the friend and companion for young or old." In literature and philosophy, his learning was profound, and his presidential address to the Classical Association at Oxford in 1919 on "The Old Humanities and the New Science" impressed his audience with his width of outlook, his easy mastery of great tracts of literature, and his all-embracing humanity in the widest sense of the term. Those who knew and loved Osler—and few men have been more personally beloved throughout the world—will feel grateful to Dr. Cushing for dwelling on the intimate aspect of Sir William's character, for revealing through his own words his infinite capacity for friendship and his unselfish aid to every one who came to him in doubt or difficulty. "He talked with crowds and kept his virtue, or walked with kings—nor lost the common touch."

Such is the story told by Dr. Cushing; the theme is noble, the book is worthy of its subject; there is little to criticise; we could have spared a page treating of the Royal College of Physicians from a mistaken point of view, and the addition of a complete list of Osler's published writings would have been desirable; but the matter is all pure gold and the book should rank as one of the classical biographies. A. S. M.

NO. 2894, VOL. 115]

## Our Bookshelf.

*Trees and How they Grow.* By G. Clarke Nuttall. New edition. Pp. xi+184+70 plates. (London, New York, Toronto and Melbourne: Cassell and Co., Ltd., 1923.) 7s. 6d. net.

MR. NUTTALL'S work is a chatty book about the botany, history, and literature of our common trees. The biological details are fairly accurate, attention being paid to the pollination of the flower, the distribution of the seed, and the growth of the seedling. Errors, however, are not infrequent in the other part of the text, mainly due to previous writers, from whom the author has compiled. The remarkable hazel tree, 60 feet high, at Syon House, Brentford, is not the common species (as stated on p. 5, an error due to Tollemache in 1901); but is *Corylus Colurna*, the Turkish hazel, a large forest tree of S.E. Europe and Asia Minor. There are actually three magnificent Turkish hazels at Syon, ranging in height from 68 to 87 feet.

The derivations of tree names in this book are mostly of the kind known as folk-etymology, and perpetuate time-honoured errors. The statement (p. 62) that the Lombardy poplar is a native of the Himalayas is without foundation, there being no doubt that it originated, as its name indicates, in the plain of the River Po. The statement (p. 16) that the word elm is a derivative of the Latin *ulmus* is incorrect, and certainly lends no support to the tradition that the common elm was introduced into Britain by the Romans. The wych elm is so called on account of its pendulous branches (A.S. *wice*, bending), and the etymology given on p. 16 is impossible. The derivation (p. 24) of the Latin *taxus*, yew, from the Greek *τόξον*, a bow, rests on a guess of Pliny and is not supported by any evidence. Absurd derivations of the Latin *alnus*, alder (p. 47), and *carpinus*, hornbeam (p. 53), are put forward. Acorn means the fruit of the open country (A.S. *æcern*), and has no connexion (as stated on p. 104) with the A.S. *ac*, oak—the present spelling "acorn" being a good example of the influence of folk-etymology on the form of words. The word holly (p. 133) is not derived from the Norse, and has no connexion with the word *holy*. The A.S. name of the tree is *holen* or *holegn*, cognate with the Irish *cuileann* and the Welsh *celyn*. This name is as old as the A.S. *mapel* (*Acer campestre*), which is said (p. 141) to be an old British name, "handed down to us from days long before Anglo-Saxons were thought of; and it is the only plant whose name has come down from those days." This is a fairy tale without any foundation. The lime tree owes its name to a corruption of the A.S. *lind*, which survives in the adjective linden; and the explanation offered by Mr. Nuttall is baseless.

The book may be serviceable in Nature study classes, as it is cheap, readable, and provided with useful illustrations.

*The Borders and Beyond: Arctic, Cheviot, Tropic.* By Abel Chapman. Pp. xxi+489+35 plates. (London and Edinburgh: Gurney and Jackson, 1924.) 25s. net.

THIS book is a fine record of personal observation of wild life at home and abroad, and sets forth the opinions arrived at by the author as the result of many years

of practical experience of his subjects. He opens by discussing many points of interest in the life of the red grouse and other game birds. Faced with such questions as "Do grouse drink?" Mr. Chapman does not need to weigh the pros and cons or to meet opposing arguments: he simply knows, and has known from boyhood, that grouse do drink, and he can tell us how, and when, and where, with a wealth of circumstantial detail. Not least interesting are the chapters on what Mr. Chapman calls the "globe spanners," those species of waders, particularly, which breed only on the Arctic tundras but migrate so far as South Africa, Patagonia, Tasmania, and New Zealand. He knows some of them in their northern homes and on their migrations in Spain and in Africa, but especially he knows them on passage on the Northumbrian coast. Various aspects of wild-fowling are also dealt with, and it is only a wild-fowler who readily becomes familiar with such birds as the brent goose. Further chapters are devoted to "salmonology," and finally the author sums up his far from complimentary views about modern zoology and bird protection laws respectively.

Mr. Chapman has the defects of his qualities. He is too much out of sympathy with those who follow different lines of study, and he often fails to recognise the limitations of his own method. Thus, he seems to claim questions of evolutionary relationships for the peculiar province of the field observer, attaching more importance to the evidence of habits than to the less plastic features of fundamental structure. Again, it is untrue that the curlew is described by British ornithologists simply as a resident species (although, as the author gracefully puts it, "the precise verbiage may vary"); and the text-books may be pardoned for not following the author's example in dogmatically defining the winter-range of British native birds. The experiment with bats which the author ascribes to Thomson was merely quoted by him.

The numerous illustrations are just what one would wish for in such a work, namely, field sketches from the author's own pencil: these are reinforced by some excellent coloured plates by Mr. W. H. Riddell.

*Tabellen zur Röntgenspektralanalyse.* Von Paul Günther. Pp. iv+61. (Berlin: Julius Springer, 1924.) 4.80 gold marks.

X-RAY spectroscopy has already invaded the domain of chemical analysis and is no doubt destined to play an ever-increasing part in this field. It is to meet such a situation that Dr. Günther has compiled this handy volume of tables. He has departed from the conventional method of classifying the lines under elements and has tabulated them in order of increasing wave-length. Such an arrangement, while suited for the special purpose for which the tables are intended, may not be very popular among physicists, who will probably prefer the more usual method; their needs have, however, already been catered for in various publications. In addition to the wave-lengths and their identification, this table gives, for the more important lines, the reflecting angles for the crystals commonly used with the spectrometer. The actual values given are largely based on the measurements of Siegbahn and his school, but in the *K* series of the elements of higher atomic weight it is surprising to find that the wave-lengths given are not those of the latest and most

accurate determinations, and differ in some cases considerably from those given by Siegbahn and de Broglie. This divergence appears to be confined to this set of lines. With this exception, the table has been very carefully constructed and is very complete. In addition, Dr. Günther gives in the introduction a brief description of the characteristics of X-ray spectra, and concludes with a series of tables on absorption coefficients, critical exciting voltages, and the like. In following the example of Siegbahn and including these tables, the author has materially increased the value of the book. The printing and general arrangement are excellent, and the volume should prove a useful reference book to all engaged in X-ray spectroscopy.

*Biologie der Tiere Deutschlands.* Herausgegeben von Prof. Dr. Paul Schulze. Lieferung 6, Teil 4: *Turbellaria*; von Erich Reisinger. Pp. 4. 64. 1s. 3d. Lieferung 7, Teil 42: *Hymenoptera*; von H. Bischoff. Teil 49: *Amphibia*; von A. Remane. Pp. 42.64+49.34. 1s. 10d. Lieferung 8, Teil 42: *Hymenoptera II.*; von H. Bischoff. Pp. 42. 65-156. 1s. 10d. Lieferung 9, Teil 34: *Ephemeroptera*; von Georg Ulmer. Teil 50: *Reptilia*; von A. Remane. Pp. 34. 40+50. 29. 1s. 8d. Lieferung 10, Teil 32: *Plecoptera*; von Ed. Schoenemund. Teil 40: *Coleoptera I.*; von H. v. Lengerken. Pp. 32. 34+40. 36. 1s. 10d. (Berlin: Gebrüder Borntraeger, 1923-1924.)

WE welcome a further instalment of the parts of this extremely useful work on the natural history of the animals comprising the fauna of Germany. About one-third of the whole has now been issued, and as publication is apparently being pushed forward rapidly, the completion of the work may be looked for at a not too distant date. The parts under notice follow closely the lines laid down by previous parts, and the high level of excellence of the earlier series is well maintained. It is perhaps invidious to select any part for special mention, but the section dealing with the Hymenoptera seems to us to be a remarkably concise account of the biology of this large and varied group of insects. A work on similar lines dealing with the British fauna is urgently needed.

*Handbuch der Balneologie, medizinischen Klimatologie und Balneographie.* Herausgegeben im Auftrage der Zentralstelle für Balneologie von Prof. Dr. Dietrich und Prof. Dr. Kaminer. Band 4. Pp. xii+379. (Leipzig: Georg Thieme, 1924.) 3.80 dollars.

THIS treatise on balneology, etc., to be completed in five volumes, deals with the subject very completely. The volume under review includes the technique of hydrotherapy, sea-water baths, radio-active waters and hydro-electro-therapy, sunlight therapy and diets, and the therapeutic action of climate—low and high altitudes, desert air, and ocean travel.

The section on sunlight therapy, by Dr. Bernhard of St. Moritz, is of considerable interest, and the illustrations showing the condition before and after treatment of patients suffering from tuberculous sinuses, wounds, and the like are a striking testimony to the value of this form of treatment.

The various sections, which are all written by specialists, give the latest available information on the subjects with which they deal.

### Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

#### The Effect of the Earth's Rotation on the Velocity of Light.

IN the *Philosophical Magazine* (6), 8, 716, 1904, an experiment was described, designed to test the effect of the earth's rotation on the velocity of light. In consequence of atmospheric disturbances, it was quite impossible to measure the interference fringes in the open air. Accordingly a twelve-inch water-pipe was laid on the surface of the ground in the form of a rectangle, 2010 ft. by 1113 ft. The residual pressure was reduced to about one-half an inch by means of a fifty horse-power pump. One of the ends was double, as shown in Fig. 1. At A, light from a carbon arc

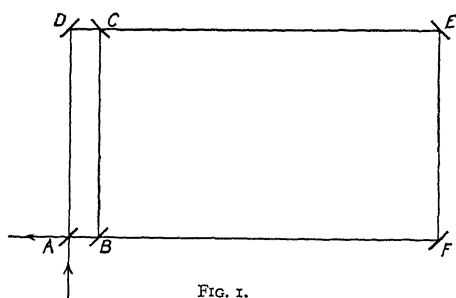


FIG. 1.

was divided by a plane parallel plate, thinly covered with gold, into two beams, one traversing the circuit in a clockwise, the other in a counter-clockwise direction.

Observations showed that the beam going in the counter-clockwise direction was retarded with respect to the other by 0.230 of a fringe.

TABLE I.

	Displacement in Fringes.	Number of Observations.	Deviation from Mean.
1	0.252	20	0.022
2	.255	20	.025
3	.193	20	.037
4	.246	20	.016
5	.235	20	.005
6	.207	26	.023
7	.232	20	.002
8	.230	20	.000
9	.217	20	.013
10	.198	20	.032
11	.252	20	.022
12	.237	20	.007
13	0.230	23	0.000
	Mean 0.230	Total 269	Av. dev from mean 0.016

Observations 1-6 inclusive, without collimator,  
7-13 inclusive, with collimator.

Displacement . . . 0.230 ± 0.005      Obs.      Calc.      0.236 ± 0.002

The theoretical value,<sup>1</sup> on the assumption of a stagnant ether, is given by the formula  $\Delta = \frac{4A\omega \sin \theta}{\lambda c}$ .

<sup>1</sup> This is twice the value given in the original article. Attention was directed to this correction by L. Silberstein in the *Journal of the Optical Society of America*, 5, 297, 1921.

With the actual dimensions of the apparatus, the calculated displacement is 0.236 of a fringe. In this formula the latitude,  $\theta$ , is  $41^\circ 46'$ , and the wave-length,  $\omega$ , as measured by comparison with sodium light, is 5700 Å.U.;  $\omega$  is the angular velocity of the earth's rotation, and  $c$  the velocity of light.

Two hundred and sixty-nine observations were made, and averaged, usually in groups of twenty, in the order taken. Thirteen such means are given in Table I.

The results are interpreted to mean that the calculated and observed displacements agree to within the limits of observational error.

A. A. MICHELSON.  
HENRY G. GALE.

University of Chicago,  
March 21.

#### Atmospheric Electric Transmission.

It appears to be of interest and value, in relation to current investigations on the circumstances of wireless transmission at short ranges, to note the intensity of reflection of electric waves that might be expected at the sharp boundary of an ionised layer, high in the atmosphere. The term sharp here implies practically that the transition is completed in, say, not less than one-tenth or, for nearly direct incidence, one-fifth of a wave-length. The relative amplitudes in the reflected waves are then, for the two polarised components, given sufficiently by the following expressions

$$-\frac{\sin(i-r)}{\sin(i+r)} \text{ and } \frac{\tan(i-r)}{\tan(i+r)}.$$

When the index of refraction  $\mu$  is  $1 - \nu$  where  $\nu$  is small, they become

$$-\frac{\nu}{2 \cos^2 i} \text{ and } \frac{\nu \cos 2i}{2 \cos^2 i};$$

e.g. for rays inclined at  $30^\circ$  to the horizontal they are  $-2\nu$  and  $-\nu$ .

For the most favourable case (NATURE, November 1, 1924, p. 650,<sup>1</sup> or *Phil. Mag.*, December, p. 1031), that of free ions,  $N$  per cubic cm., unhampered by collisions, therefore high up, the value of  $\nu$  is

$$\frac{1}{2} N \lambda^2 \frac{e^2}{\pi m},$$

which is  $\frac{1}{2} \times 10^{-3} N$  for free electrons and for wave-length of one kilometre. To ensure a reflection of 10 per cent. in amplitude (or 1 per cent. in energy) of rays inclined at  $30^\circ$  as above,  $N$  would have to be about 300 electrons or else  $5 \times 10^5$  hydrogen ions per cubic cm. If the wave-length is 10 times smaller, namely, 100 metres, these numbers have to be multiplied by 10<sup>2</sup>.

At the other extreme, if a gradual transition is to bend round the complete ray through the same angle of  $60^\circ$  in traversing a curve of whatever length, the difference of the values of  $N$  at the top and bottom of this curved path figures out (*cf. loc. cit.*) of the order of 300 electrons per cubic cm. when  $\lambda$  is one kilometre, much the same density of ions being thus necessary in the two cases.

For the first case, however, that of transition practically sharp, a layer a few wave-lengths in thickness would play the part of Newton's thin plate in optics; by reflecting from both its faces: thus as the wave-length is gradually changed, there would be regular fluctuations at the receiver. Ionic clouds drifting across the sky might cause irregularity of

<sup>1</sup> At top of column 2 read  $\frac{1}{2} \times 10^{-3}$  watts per square cm.

communication in this way. In the other case, two regions, each with  $N$  increasing upwards, would be required for such interference.

According to observations recently reported, wave-fronts guided along the ground are inclined to the vertical at an angle  $\alpha$  of the order of a degree at most; as the fronts travel with their proper velocity  $c'$ , appropriate to air, their trace travels along the ground with velocity  $c'/\cos \alpha$ : this does not differ enough from  $c'$  to show interference at the receiver between ground waves and free air waves.

JOSEPH LARMOR.

St. John's College, Cambridge,  
April 5.

### Diffusion of Momentum by Air Currents.

THERE is a wide difference between the actual rate at which contiguous streams intermix and that indicated by the ordinary theory of stream-lines supplemented by corrections for the effect of viscosity. In this theory, for non-viscous fluids, the total energy of every element is identical and constant, and the boundary conditions and those of continuity must be satisfied. With the assumption that the motion is stable, these suppositions lead to the following conclusions: The flow is irrotational. A solid of any shape whatever would experience no resistance, but when once started would continue to move with a constant velocity. There is a variation of pressure over the leading surface which is exactly balanced by corresponding variations at the rear end.

It is only in exceptional cases, and where fish-shaped forms are concerned, that any approach to the realisation of this kind of flow occurs in Nature, but in such forms where the cross-section area of the solid changes very gradually, there is a considerable replacement at the stern of the excess of pressure on the head. Any abrupt change of section causes the stream-lines to leave the surface of the solid.

Another solution of the stream-line problem leads to results which have more resemblance to reality. In this the fluid is divided into two regions by a bounding surface of which that of the solid forms a part. In both regions the pressures at a distance are the same but the velocities are different. Any portion of the fluid wholly within either region is without molecular rotation. Rotation, however, will exist if the part chosen includes any part of the boundary. The form of the boundary (when the solid is a plate moving in the direction of its normal) is sketched in Fig. 1.

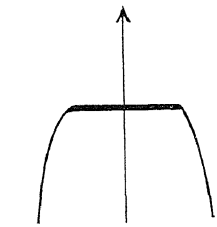


FIG. 1.—Form of the discontinuous stream-lines of a flat plate moving in the direction of the normal.

hence this class of stream-line cannot be initiated by any practicable method.

Lord Kelvin pointed out that though this solution did not properly apply to a solid immersed in a fluid, the calculated shape of the boundary does accurately represent the shape of the vacuous cavity which would be formed on the down-stream side of the solid were no such force as gravity in action.

The striking difference between the real and calculated motions of fluids depends primarily on the

instability of the latter. If in any group of stream-lines the flow at some point in one tube is artificially retarded for a moment, expansion occurs in that tube and the pressure increases. At the same time, the conditions of continuity cause a constriction in the neighbouring tubes with a corresponding decrease of pressure. Hence such a disturbance, once started, has no tendency to die out, and the "aneurism" in the retarded stream will continue to grow.

Suppose that in a large body of fluid a small spherical portion were set in motion by an impulse. At the first instant the pressures would be arranged as shown in Fig. 2, *a*, and if flow of the "electric" type continued, the momentum would be confined to the sphere, which, however, would alter its shape under the action of the surface forces, gradually spreading into a thin circular sheet, the velocity of the centre of mass remaining constant. But although at the start the electric type of motion must prevail, it will last only for a moment, and before any appreciable distance has been travelled, the stream will have left the spherical boundary and taken the form shown in Fig. 2, *b*.

The mass originally set in motion still tends to spread into a sheet, but this will no longer remain flat, and in the course of time its edges turn backwards and inwards, eventually forming a kind of annular eddy half made up of fluid from the sheet and half from the fluid behind it (see Fig. 2, *c* and *d*). The rings produced by puffs of air issuing from a symmetrical orifice (and often wrongly called "vortex" rings) are formed in this way.

If, instead of single puffs, a continuous stream of air is expelled, the effects of instability may take different forms. When the velocity of issue is small, and the surrounding air perfectly still, the stream may remain straight and unbroken for many times its own diameter, but sooner or later it begins to wander like a river in an alluvial plain, and wherever these bends occur, the stream section changes to a ribbon-like form with a roll at each edge. As soon as the river-bends make acute angles with one another the stream spreads into broad sheets which soon become inextricably mixed, the whole having a strong resemblance to cumulus clouds.

If the air into which the stream issues has the smallest velocity across the orifice, the change to ribbon form starts at once, and in favourable conditions (that is, where the velocities are small and regular) the column expands fan-wise with proportionately growing rolls at each edge. This may often be seen when a cigarette end is smouldering in nearly still air, and I have once or twice seen the same phenomenon over a factory chimney, the width of the upper part of the fan certainly exceeding two hundred feet. Out-of-door weather conditions, however, make such perfect examples very rare.

The terminal condition of all mixed currents is what I have referred to as the "cumulus" state, and in appearance it may vary from well-separated sheets with rolled edges to densely packed and voluminous

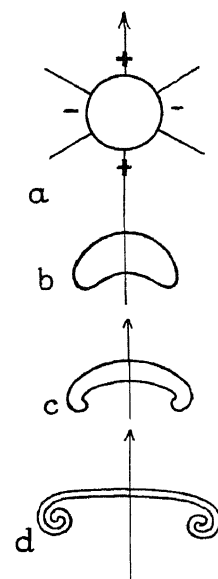


FIG. 2.—*a*, distribution of pressure round a sphere, when the flow is of the "electric" type. The signs + and - signify that the pressure is greater or less than that of the fluid at a distance. *b*, *c*, and *d* indicate the successive forms taken by the sphere in real fluids, leading in the end to the formation of a ring.

clouds, according to the relative velocities of the parts. It can be recognised on various scales ranging from a puff of tobacco smoke to the motions in solar prominences.

The tendency of streams to spread into sheets under the influence of instability is quite general, and appears to be the chief agent in the diffusion of momentum.

Smoke forms a convenient means of making these motions visible to the eye; and the accompanying reproductions of photographs (Fig. 3) illustrate the smoke columns formed above a lamp fed with xylol. The latter yields a dense smoke, and the photographs, besides showing the various phases of instability, indicate also the manner in which "blacks" are formed. The carbon deposited in combustion is



FIG. 3. Reproduction of photographs of smoke columns. The

swept into the rolls bordering the spreading sheets.<sup>1</sup> These rolls become broken up in the "cumulus" stage, and here the blacks are seen in all positions.

A large number of photographs has been taken (using a spark from a Leyden jar as the illuminant), but those reproduced are fairly characteristic.

There is a curious quasi-periodic arrangement in the "blacks" where the smoke column is unbroken, the time interval being of the order of 1/150 to 1/200 second. It appears in all the photographs, though not clear in the small scale reproductions, but what the origin of the period may be I do not know.

A. MALLOCK.

9 Baring Crescent, Exeter,  
February 12.

#### A Course of Faraday.

NATURE is no longer merely "a weekly journal of science" but now both looks after our literary p's and q's and often is full of humour. This is right and proper. We have only to think what science would be, if, for example, we took seriously imperious dismissals of the ether, such as we are favoured with by a high official of the Royal Society. The delightful way in which other guardians of cosmic theory agree to differ is worthy of the best traditions of the House of Commons, if not of the Geological Society in its most palmy disputatious days. We still need, however, to introduce some sense of the ridiculous into chemistry. The reviewer ("Our Bookshelf," March 14) is hard on the author of "Practical Forestry," who, after asking, "Why is coal put between species

<sup>1</sup> When the "blacks" are caught in a suitable bedding material and sectioned, the volute structure can be recognised.

of stone or rock?" replies, "Because the Almighty put it there, and no expert or scientist breathing will ever make the writer believe otherwise." "Scientific truth" is stranger than such fiction. Physical chemists, biologists too, speak in just the same way of the tectonic myths they administer to unquestioning would-be graduates in science. What, indeed, is the professor for but to profess? His not to reason why, his but to do or die, at the hands of the examiner.

My fancy has been specially tickled by the "Alice in Wonderland" title, in which my name appears, at the head of a letter on March 14: "Graphitic Conduction in Conjugated Chains of Carbon Atoms: a Contribution to Armstrong's Theory of Chemical Change." I could never have supposed that any "theory" I might propose would be hung in such "Conjugated Chains." The nearest thing to "Graphitic Conduction in Conjugated Chains" I can think of is the school lesson the Mock Turtle had in *Fainting in Coils*.

What is all the fuss about? What is Graphitic Conduction? A chemical *Tar Baby*, perhaps? I wonder. Why this christening party over conduction at all? Surely the two recognised forms, metallic and electrolytic, meet our needs.

The writer of the letter has a most unconscionable and reprehensible habit of putting new labels upon over-labelled bottles. I suppose, a trick acquired by constant association with a society the great aim of which seems to be to propagate Christian names among chemists. In the very first paragraph, he insults two dear old friends of mine, ethylic acetate and nitrocamphor, the latter one of my own failed-children, by calling them *prototropic compounds*—a first-aid or first-love sort, I can only judge from my knowledge of Greek. He ought to have been in the Church—to satisfy his lust to proselytise and re-christen. This is an unnecessary act of word-pornography, in my opinion. Elsewhere, he has called water an *Ampholyte*. Poor molecule. If hydrolyte be something which can be cut by water, ampholyte must imply something that can be cut by two: we gain nothing from such vicarious, bemuddled super-naming. It is more than a shock to me that one of my most distinguished pupils, whose laboratory work is of such exceptional merit, should develop so perverse a habit.

While re-naming unnecessarily, he seems to have no clear conception of the meaning of the old words he uses and not much "feeling" for the process he is discussing. To me, however, his letter is of extraordinary psychological interest. After many years wandering in a mythical wilderness of Arrhenius ions and mathematical jugglery, the writer seems at last to be "feeling a want" to return to a watered and more fertile region. The doctrine I vainly endeavoured to plant in his soul seems to have been in subconscious operation and is now coming to the surface: the son, I am inclined to believe from close observation in my own family, does tend, more and more, to resemble his parent as years go on. The explanation my old pupil advances of the isomeric change he discusses is in principle, though in a very stilted form, that current in our laboratory from the time that Mr. Briggs and I discovered that the change of acetylphenylchloramine into the isomeric chloranilines was due to a trace of chlorhydric acid.

NATURE is not the place to discuss so technical a problem further. At the moment, what we most need in chemistry is to get down to fundamental facts, to consider what is known and to treat this in the simplest possible terms. I recommend a course of Faraday to this end. I have not the slightest desire to receive recognition of any views I may have put

forward—the time for that sort of thing is past. What I do desire to see, however, is an attempt by chemists to be logical and to follow the as yet dimly written canons of scientific method. There is little health in much of the present science, because there is no law in it. My pupil's attempt to clear his mind, by discussing a chemical problem with some regard to the process of change, is a great departure from the current practice. I am grateful to him for the advertisement he would give to my "dictum," as he calls it. Not my dictum—but Faraday's finding and assertion, dating as far back as 1833.

I would urge my good trumpeter to follow the example of Michael Pupin, the one-time Serbian peasant boy, as set out in his charming autobiography, "From Immigrant to Inventor." Pupin tells how he came to Cambridge (England) and was coached by Dr. Routh but dared not enter as a student under J. J. Thomson, then recently appointed professor, only two years his senior—because he knew nothing of practical physics. So he bought there the three volumes of "Faraday's Collected Researches in Electricity," for three shillings, a wonderful proof of the esteem in which electricity was then held in Cambridge (England) but still about or above the value put upon the books by chemists to-day. He adjourned with these to Corrie, in Arran, but for a time took instead to practising the Highland Reel, in Glen Sannox, under the engaging tuition of a Scotch lassie. Eventually, however, like Moses, he went up to the mount, to a crofter's hut, where he lived simply on oatmeal porridge and Faraday. So it came that his mind was filled with visions of electromagnetic theory, with the result that he is now a wealthy man, through the invention of the loading coil used in reinforcing telephone circuits.

I bought Faraday's three volumes in a job lot of books, in the early 'seventies, at Stevens' auction rooms, at a not much higher price than Pupin did. I was specially fascinated by the electrochemical researches and those on the catalytic action of platinum. I read these over and over again—eventually I became a public preacher of Faraday's doctrine of the unity of chemical and electrolytic change. I should add that, at an earlier period, I had learnt to have faith in oxygen, indeed, to reverence it among the elements—a faith the modern "chemist" lacks. He will not be a chemist until he recover it. I would advise my old pupil and all who desire to arrive at an understanding of chemical change to retire into the mountains with Faraday's volumes and Wiedemann's "Electricität" and really study them—with or without the aid of Highland lassies but taking into account the wonderful work done by H. B. Dixon, H. B. Baker and Lowry on the conditions of chemical change. Dancing, of course, is in these days an act of Nature. Let them, however, learn to dance to the simple old melodies, not to the loose and illogical jazz which has so long hypnotised their minds.

One final sentence as to graphitic conduction. Surely there is no reason to believe that it is otherwise than electrolytic and due to an impurity—to intruded salts—like that of quartz. As to alternate single and double bonds in benzene, the conception probably exists only on paper. The facts all tend to show that the six atoms in a "chunk" of benzenoid carbon are equally related, hexagonally not trigonally. This is the idea underlying my *Centric Symbol*, which, I submit in all humility, is the nearest approach to a plane formula yet devised or likely to be. We shall not know benzene until we think of it corporeally—not as a few straight strokes with the pen.

HENRY E. ARMSTRONG.

### Some Notes on the Taungs Skull.

A FEW days ago I visited Johannesburg to have a look at the remarkable new skull discovered by Prof. Dart, and named by him *Australopithecus africanus*. Prof. Dart not only allowed me every facility for examining the skull, but also gave me with almost unexampled generosity full permission to publish any observations I made on it, and suggested further that I might send to NATURE any notes that might amplify the account he had already given. As the skull is one of extreme importance, a full account with measurements and very detailed figures will in due course be published by Prof. Dart, but the world already realises the unique character of the discovery and is anxious for more immediate information.

From the cablegrams received in South Africa, it is manifest that the first demand is for further light on the geological age of the being, and unfortunately complete information on this point cannot now be given, and will possibly never be available. Though I have not myself visited the Taungs locality, I am fairly familiar with many similar deposits farther south along the Kaap escarpment. This escarpment runs for more than 150 miles along the west side of the Harts River and lower Vaal River valleys from a little south of Vryburg to 20 miles south of Douglas. The escarpment is formed for the most part of huge cliffs of dolomitic limestone of the Campbell Rand series, in most places some hundreds of feet thick. The wide valley has an interesting geological history. Originally it was carved out in Upper Carboniferous or Lower Permian times by the Dwyka glaciers. For millions of years it was steadily refilled by Dwyka, Ecca, and Beaufort beds until the whole valley was perhaps buried by more than 2000 feet of Permian and Triassic shales. Then conditions changed and the valley was re-excavated, by denudation, until to-day we find it not unlike what it must have been when originally carved out by the Dwyka glaciers.

The dolomite escarpment forms the most striking feature of the landscape in this part of the world. All along the west of the Harts-Vaal valley lies the high dead-level Kaap plateau, and when viewed from 20 miles away the escarpment looks like a high black wall bounding the lower plain of the valley. Every five or ten miles along the black wall are to be seen large light-coloured patches which on examination prove to be great masses of calc-sinter formed by calcareous springs. These, of course, must have been formed after the dolomite cliffs had been denuded of their covering Dwyka shales, and may in some cases be of considerable age—perhaps even dating from moderately early Tertiary times. Other masses of this secondary limestone may be of comparatively recent date. In places the great masses of calc-sinter have been excavated by underground water and moderately large caves are formed.

At Taungs the mass of secondary limestone is some hundreds of feet thick and about 70 feet high where it is being worked. Already 250 feet have been quarried away. On the face about 50 feet below the top of the mass, an old cave is cut across which is filled up with sand partly cemented together with lime, and it is in this old cave that the skull of *Australopithecus* has been found. The only other bones that I have seen or heard of are skulls and bones of a baboon, a jaw of a hyrax, and remains of a tortoise. I have not seen the hyrax jaw, so cannot say if it belongs to one of the living species. The baboon has been examined by Dr. Haughton, who regards it as an extinct species and has named it *Papio capensis*. I have seen a number of imperfect skulls of this baboon, and while they belong to a different species from the living local

*Papio porcarius*, the difference between them is not so very striking.

I think it can be safely asserted that the Taungs skull is thus not likely to be geologically of great antiquity—probably not older than Pleistocene, and perhaps even as recent as the *Homo rhodesiensis* skull. When later or other associated mammalian bones are discovered, it may be possible to give the age with greater definiteness. At present all we can say is that the skull is not likely to be older than what we regard as the human period. But the age of the specimen in no way interferes with its being a true "missing link," and the most important hitherto discovered.

Prof. Dart in his photographs has given the general features of the skull and the brain, but there are a number of important characters in the skull and dentition to which I should like to direct attention.

Though the parietals and occipital are almost completely lost from the brain cast, most of the sutures can be clearly made out, and are as I indicate in Fig. 1. The sutures in the temporal region can

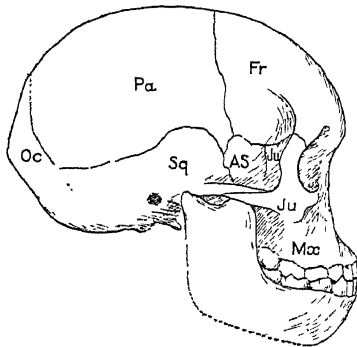


FIG. 1.—Side view of skull of *Australopithecus africanus*, Dart. About  $\frac{1}{3}$  natural size.

also be clearly seen. The suture between the temporal bone and the parietal is fairly horizontal as in the anthropoid apes, but in the upward development of the squamous portion we have a character which is human and not met with in the gorilla, the chimpanzee, the orang, or the gibbon.

The arrangement of the sutures in the temporal region is also remarkably interesting. The upper part of the sphenoid articulates with both the parietal and the frontal. In the gorilla and chimpanzee in all the drawings I can find, the temporal bone meets the frontal and prevents the meeting of the sphenoid and the parietal. In the orang the condition varies, and I have in my possession a skull which has on the right side a sphenoparietal suture and on the left a frontotemporal suture. In the baboon there is a large frontotemporal suture, and in *Cercopithecus* a sphenoparietal suture. In the gibbon there is also a sphenoparietal suture. While the arrangement of the sutures in this region may not be of very great fundamental importance, it is interesting to note that *Australopithecus* agrees with man, the gibbon, and *Cercopithecus*, but differs from the gorilla, the chimpanzee, and the baboon.

The jugal or malar arch is interesting in that there is a long articulation between the jugal and squamosal. In this *Australopithecus* agrees rather with the anthropoids than with man.

On the face there are one or two striking characters, and of these perhaps the most important is the fusion of the premaxilla with the maxilla. On the palate the suture between these bones is seen almost as in the human child, the suture running out about two-thirds of the way towards the diastema between the second incisor and the canine. On the face there is

no trace of any suture in the dental region, but on the left side of the nasal opening there is what is probably the upper part of the original premaxillamaxillary suture. On the right side there is a faint indication of a suture just inside the nostril. In the chimpanzee the suture becomes obliterated in the dental region early, as apparently is the case in *Australopithecus*. In the orang and gorilla the suture remains distinct until a much later stage. In man, as is well known, all trace of the suture is obliterated from the face long before birth.

*Australopithecus* agrees with man and the chimpanzee in having a single foramen for the superior maxillary nerve. In the orang, gibbon, and other apes there are usually two or more foramina. In the gorilla sometimes there is one foramen; sometimes two.

In the shortness of the nasal bones and the high position of the nasal opening the Taungs skull agrees more with the chimpanzee than with the gorilla.

The dentition is beautifully preserved, and the teeth have been cleared of matrix by Prof. Dart with the greatest care. Though, owing to the lower jaw being in position, a full view of the crowns of the teeth could only be obtained by detaching the lower jaw, a sufficiently satisfactory view can be obtained to give us practically all we require of the structure.

The whole deciduous denture is present in practically perfect condition. The incisors, which are small, have been much worn down by use, and most of the crowns of the median ones have been worn off. Prof. Dart has directed attention to the vertical position of the teeth, which is a human character and differs considerably from the conditions found in the chimpanzee and gorilla. The small size of the incisors is also a human character.

The relatively small size of the canine is a character in which *Australopithecus* agrees with both the chimpanzee and man, and lies practically between the two.

The deciduous molars agree more closely with those of man than with those of any of the apes.

The first permanent molars of both upper and lower jaws are perfectly preserved and singularly interesting.

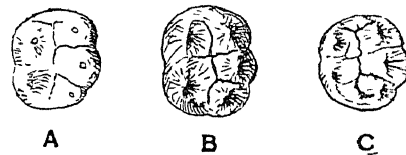


FIG. 2.—First right upper molars: A, orang (after Rose); B, *Australopithecus africanus*, Dart, unworn; C, Bushman child, unworn. All natural size.

The first molar of the upper jaw (Fig. 2) has four large cusps arranged as in man and the anthropoid apes.

The first lower molar (Fig. 3) has three well-

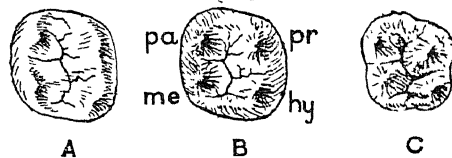


FIG. 3.—First right lower molars: A, old (after Miller); B, *Australopithecus africanus*, Dart; C, Bushman child. All natural size.

The arrangement of the furrows on the crown of the molar of *Australopithecus* is almost exactly similar to that in both the orang and the Bushman. In the chimpanzee and gorilla, there is usually a well-marked ridge passing from the protocone to the metacone, of which there is an indication in the Bushman tooth.

developed sub-equal cusps on the outer side and two on the inner. Though in its great length and in the large development of the third outer cusp or hypoconulid the tooth differs considerably from the typical first

lower molar of man, teeth of this pattern not infrequently occur in man. In general structure, however, the tooth more closely resembles that of the chimpanzee. It is interesting to compare this tooth with the corresponding tooth in *Eoanthropus*.

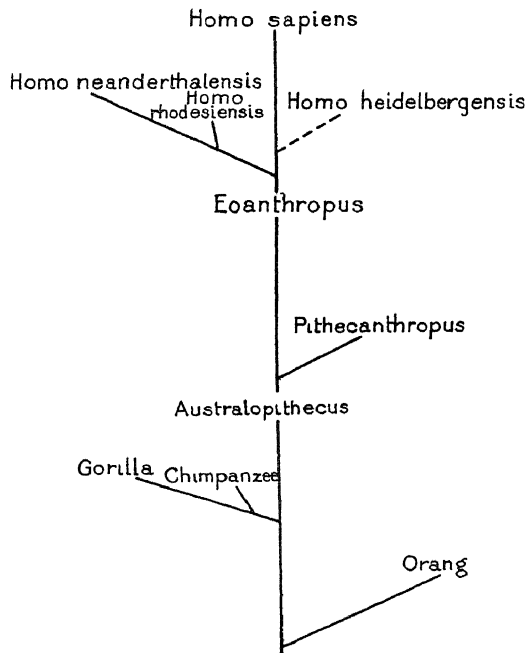


FIG. 4.

It will be seen that in *Australopithecus africanus* we have a large anthropoid ape resembling the chimpanzee in many characters, but approaching man in others. We can assert with considerable confidence that it could not have been a forest-living animal, and

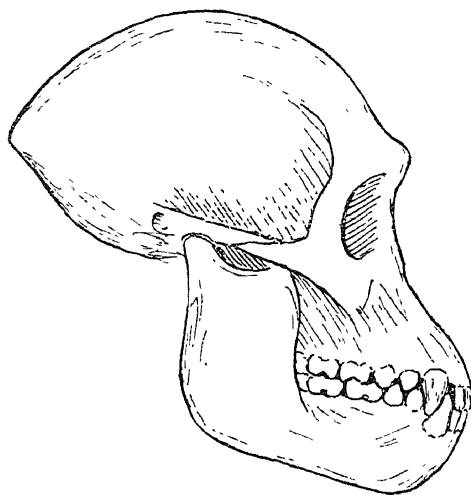


FIG. 5.—Attempted reconstruction of adult skull of *Australopithecus africanus*, Dart. About  $\frac{1}{3}$  natural size.

that almost certainly it lived among the rocks and on the plains, as does the baboon of to-day. Prof. Dart has shown that it must have walked more upright than the chimpanzee or gorilla, and it must thus have approached man more nearly than any other anthropoid hitherto discovered.

*Eoanthropus* has a human brain with still the chimpanzee jaw. In *Australopithecus* we have a being

also with a chimpanzee-like jaw, but with a sub-human brain. We seem justified in concluding that in this new form discovered by Prof. Dart we have a connecting link between the higher apes and one of the lowest human types.

The accompanying table (Fig. 4) shows what I believe to be the relationships of *Australopithecus*. If an attempt be made to reconstruct the adult skull (Fig. 5), it is surprising how near it appears to come to *Pithecanthropus erectus*—differing only in the somewhat smaller brain, and less erect attitude.

While nearer to the anthropoid apes than man, it seems to be the forerunner of such a type as *Eoanthropus*, which may be regarded as the earliest human variety, the other probably branching off in different directions.

There seems considerable probability that adult specimens will yet be secured, and if the skeleton as well as the skull is preserved, the light thrown on human evolution will be very great. R. BROOM.

Douglas, South Africa.

### The Skull of Robert the Bruce.

A LETTER to NATURE is perhaps not the suitable place to discuss the historical evidence for sporadic syphilis being well known in Europe from at least the ninth century, nor do I intend at present to controvert Sir Arthur Keith on several other points in which he disagrees with me in his recent friendly review of my "Bruce" (NATURE, February 28, p. 303). But there is one point at which Sir Arthur seems to me to show less than his usual acumen. He concludes his article with the words: "The writer [Sir Arthur] has searched the pre-medieval graves of England and Scotland for traces of syphilis and found none, and those who know our medical records believe that Robert Bruce had been asleep in Dunfermline Abbey for two centuries before this fell disease appeared in Britain."

Now I strongly suspect that Sir Arthur Keith has overlooked two important considerations: (1) that he has been thinking largely of skeletons dug up from abbeys, and (2) that he has disregarded the fact that the nature of a disease changes with the centuries. Now abbeys in the tenth to the thirteenth centuries were not those seats of vice that a good compatriot of George Buchanan naturally assumes them to have been. Further, the sporadic cases of the disease were undoubtedly confused with leprosy, and it is not in the abbey graveyards, or in the churchyards of the tenth to the fourteenth centuries that I should expect to find evidence of these sporadic cases of syphilis. Sir Arthur should search in the burial-places attached to leper-houses, and even then he must not expect of a certainty to find the osteological appearances identical with those of the post-pandemic times.

St. Hildegard in her "Causae et Curae" of the twelfth century describes under leprosy cases which are certainly not leprosy, but as certainly syphilis. She was quite familiar, as Hildebrand has lately demonstrated, with the general paralysis of the insane. The same writer has also recently proved beyond a doubt that St. Odo of Cluny (circa 930) was acquainted with the disease as a result of sexual licence:

Irrepsit vitium—nec jam est simplex neque solum.  
Ulcus enim vultum foedans facit esse probrosum,  
Et vitium attaminat membrum, cui forsan adheret  
At si vulnus abit, de more glabella nutescit,  
Membra decore suo renitent vitiisque revulso.  
Post lapsum sensus terebrat quasi zima libido;  
Illicit, illecebrat, tabo crapulosa saginat.

How shall a man in such state appear on the Day of Resurrection? the worthy Abbot demands. Even the "saddle nose" so characteristic of the tertiary stages of the disease was recognised in association with sexual licence in the eleventh century. The recent studies of Karl Sudhoff and Philipp Hildebrand seem to me to demonstrate that syphilis existed in Europe, if not in the pandemic form of the fifteenth century, still in not very infrequent cases from the early Middle Ages onwards.

Sir Arthur writes that the "very able medical men who examined the king's skull and bones" had no suspicion in their minds of syphilis. Possibly not; their report is very inadequate, and they held probably the orthodox view, like Sir Arthur, that syphilis was unknown in Europe before the time of Columbus. But these same medical men did direct attention to the condition of the upper jaw, and to the exfoliated wound on the right side of the sagittal suture, and endeavoured to give explanations of them. These explanations may be correct, but there is the awkward fact that Bruce is said to have died of "leprosy" still unaccounted for.

KARL PEARSON.

Eugenics Laboratory,  
University of London.

IN his interesting letter Prof. Pearson discusses two questions: (1) Did Europeans suffer from syphilis before the return of Columbus from America? (2) Does the skull cast of Robert Bruce give any indication that the king suffered from syphilis? I can see nothing in the skull cast symptomatic of this disease; the points mentioned by Prof. Pearson are not in my opinion indicative of syphilis.

If syphilis had existed among the Romano-Britons or Saxons, I should have met traces of it by now. There was no syphilis in ancient Egypt; of the many thousands of skulls and bones which have been examined, not one showed the unmistakable lesions of syphilis. I confess that the rise and spread of syphilis in Europe during the sixteenth century is an enigma. It can scarcely have come from America for syphilis has not been seen in graves of a pre-Columbian date. Lately it has been announced that the lama of South America has been found to be highly susceptible to syphilis. Is it possible that syphilis was not evolved as a disease of the human body?

A. KEITH.

#### A Peculiarity of some Red Neon Lines.

THE neon discharge lamps recently introduced by Messrs. Adam Hilger for spectroscopic purposes are so convenient that they are likely to be widely used. It may, therefore, be worth while to direct attention to a peculiarity of some lines of their spectrum. In the course of work with a Fabry-Perot etalon, two of the lines appeared to be doublets—in particular, the strong red line  $\lambda 6402$ , and less noticeably  $\lambda 6143$ . By immersing the lamp in liquid air the effect was accentuated and also made to appear in the line  $\lambda 6334$ .

Reference to the literature of the subject showed that some disagreement exists as to the wave-length of the line  $\lambda 6402$ , e.g.

Meissner . . . . .	6402.246 Å.
Burns, Meggers, Merrill . . . . .	6402.245 Å.
Takamine . . . . .	6402.2392 Å.
Priest . . . . .	6402.2395 Å.

Further, it was found that this line, together with a number of others, had been recorded as reversed by Meissner (*Ann. der Phys.*, 51, 1916) using a Fabry-Perot interferometer, and also by Perard (*Comptes*

*rendus*, 1923), who deduced the reversal from the visibility of the fringes seen with a Michelson interferometer. Meissner interpreted the appearance as a reversal rather than as a doubling, since it seemed to vary with the thickness of gas traversed by the light. Reference to the Paschen series scheme for the neon spectrum reveals that all the affected lines are there classified as  $1.5S_m - 2p_n$ ; that is, they belong to the principal series, as we should expect if the effect is a genuine reversal. It seems, however, from the work of Hertz on the excitation potentials of neon (*Zeits. für Phys.*, 22, 1924) that a better classification would be  $2S_m - 2p_n$ , with the quantum number 2 associated with the  $S_m$  states. Such a classification implies that it is absorption by excited neon which causes the reversal; this is borne out by some recent quantitative measurements by Meissner (*Ann. der Phys.*, Jan. 1925) and the results of Buisson and Jausseran (*Comptes rendus*, Feb. 1925). It thus seems scarcely possible to doubt that the lines are genuinely reversed, but it is surprising that with  $\lambda 6402$  the effect should be seen in a transverse view of a narrow capillary, as I have found to be the case.

The practical importance of the matter lies in the fact that the lines in question are rendered by this behaviour unsuitable for use as standards in work of the highest precision, since the effective wave-length is liable to vary with the experimental conditions. In cases where the resolving power is adequate to show the reversal clearly, the wave-length of the reversal could no doubt be safely used as a standard. For the wave-length of the reversal of  $\lambda 6402$  I find  $6402.251 \pm 0.001$  Å.

The presence of the reversal and its remarkable fineness makes the line  $\lambda 6402$  especially valuable as a convenient "test line" for etalon adjustment. A 1 cm. etalon should just show it.

A list of the lines found by Meissner to be most affected is appended. It is unfortunate that it comprises most of the strong lines in the red and yellow regions.

Intensity.	Wave-length.	Absorption.
		(Per cent.)
25	5944 Å.	50
45	6143	62
20	6266	49
35	6334	56
100	6402	74
60	7032	56

Some other lines are also affected, but not sufficiently, it is thought, to render them unreliable as standards.

W. H. J. CHILDS.

King's College, Strand.

#### The Fate of the Cyst of Monocystis in the Avian Gut.

TEXT-BOOKS do not tell us whether the cyst of *Monocystis* can pass unharmed through the gut of the bird which eats it.

With the view of elucidating this point, I fed earthworms with wheat to a Rhode Island Red hen for three days; the faeces examined revealed the presence of a few separate pseudonavicellæ and one complete cyst.

VLADIMIR IGNATIEFF.

S.E. Agricultural College  
(University of London),  
Wye, Kent,  
February 23.

## The Dinosaur Region in Tanganyika Territory.

By C. W. HOBLEY, C.M.G.

THE expedition despatched to Tanganyika Territory in 1924 to explore the occurrence of dinosaur remains has recently attracted a considerable amount of public attention, for the fossil-bearing deposits are being successfully worked and a considerable amount of material is now on its way to the British Museum. It may, therefore, be of interest to describe the area in which the finds were made. From Kenya Colony southwards, through Tanganyika Territory to Portuguese East Africa, the framework of the eastern portion of the continent is composed of an extensive series of ancient metamorphic rocks, mainly gneisses and schists, and often intersected by pegmatite veins. In some parts these rocks stand out in a series of bold mountain ranges alternating with flat plains; in other parts the mountain ranges are only represented by isolated peaks and rocky kopjes called *Inselberge* by German geologists.

On the eastern flank of this old land surface a series of sedimentary rocks are found, varying in age from Permo-Carboniferous or Karroo up to Tertiary, and it is in this strip of country that the beds carrying dinosaur remains are found.

The Karroo beds need not detain our attention, for although of great general interest on account of their being the coal-bearing series of South Africa, they are poorly represented in this region, and dinosaurs had in those times not yet made their appearance on the scene.

South of the Rufiji river in Tanganyika Territory there is a large area widening out southwards towards the Rovuma. This is covered with a varied range of sedimentary rocks of Secondary age dating from the Upper Jurassic, and containing representations of the Wealden beds and the Cretaceous, and so on, up to some Tertiary deposits the exact position of which is uncertain. The presence of these beds is evidence of a series of invasions of the sea alternated by periods of elevation and erosion. By great good fortune Nature has preserved for us in these beds the remains of some of the most curious and at the same time the biggest creatures which ever peopled this earth. There are three beds bearing saurian remains, the two lower being referred to the Upper Jurassic and the top one to the Wealden period. Information has recently also come to hand of the discovery of deposits in northern Nyasaland, which also carry saurian fossils, and although detailed information is scanty at present, it may mean that the habitat of these ancient monsters will be proved to be of much greater extent than was previously expected. Maybe these deposits formed a continuous sheet over this part of Africa before the Rift Valley subsidence in Tertiary times.

Why this region was so well suited for these creatures, and what the conditions were which enabled them to exist in such numbers, are very intriguing questions, the answer to which is not readily forthcoming; only lengthy and extensive research will afford data necessary for any definite opinion. So much for the past, and some will ask what the country is like to-day. In physiographical terms, it is a dissected plateau having a maximum height of about 2500 feet, of which only comparatively few patches remain. To the east and

north-east it slopes gradually coastwards, and on the west side it descends abruptly to the old metamorphic floor. The principal areas of more elevated country which indicate the former land surface are the Makonde, Rondo, Mbwala, and Ngarama plateaux.

In the neighbourhood of the river valleys cliffs are sometimes seen, due to the unequal erosion of beds of varying hardness, and we thus get forms which remind one of the *butte* or *mesa* of North America.

One of the latest phases of earth movement in this part of Africa was a depression, for the mouths of the rivers are submerged valleys. Permanent water is found in the main rivers, but in the network of tributaries, which help to determine the topography, the supply of water is exiguous; the rocks are generally very porous, the torrential but short spring rains produce a temporary rush of water, which rapidly soaks away during the ensuing long dry season, leaving only a few brackish pools to form breeding places for myriads of mosquitoes.

It is a depressing country to travel through, or to work in; for it is covered from end to end with the monotonous and typical bush which mantles so many thousands of square miles in eastern Africa. This bush country is here locally known as the *pori*, farther north it is called the *nyika*, and it is composed of an assemblage of acacias and wait-a-bits, interspersed with various kinds of xerophytic shrubs, with aloes, sansevieria, and euphorbias, encephalartos (a *zamia*), and that characteristic African monstrosity, the baobab. It is not uniformly dense; in fact, there are large stretches of country of an orchard-like character and carrying a rank growth of grass among the trees, and in such places a certain amount of game may be seen. The course of the rivers is often marked by a belt of fine trees, mimusops and such like, also phoenix palms.

The plant assemblage is a reflection of the meteorological conditions, for once we leave the actual coastline the rainfall becomes steadily less. The rainfall at Lindi is 32.7 inches; twenty miles inland it would probably be about half the amount, and the bulk of it will fall within about a couple of months or so. All along the east coast the small extent to which the monsoon rains affect the zone of the country for about 200 miles inland is a remarkable phenomenon. The moisture-bearing clouds do travel inland, but the hot air rising from the great belt of bush country appears to inhibit precipitation except where the clouds strike a mountain range; the cooler mass then causes some of the moisture to fall thereon, but the bulk sweeps on until it strikes some high plateau far inland.

As might be expected, such rigorous natural conditions have not made for great human progress or dense associations of human beings. A heterogeneous collection of people is scattered about on the flanks of the river valleys and on the higher parts of the plateau. They are all what is known as Bantus, the principal tribes found in the area being the Wa-Mwera, Wa-Makonde, Wa-Yao and Wa-Ngindo, Wa-Ngoni and Wa-Makua.

The Angoni, as is well known, are representatives of the great northward migration of part of the Zulu race,

which took place somewhere about 1825; it did not reach this region, however, until considerably later, and did not lead to a very extensive settlement; the Yao have also come from the south-west during the last fifty to sixty years, not in mass, but as a peaceful penetration; they are a virile race, and their arrival is a desirable thing for this region.

These coastal lands have been the scene of raids and counter-raids from time immemorial. In medieval times they were swept by the irresistible Ma-Zimba, and later were ravaged by Arab slave traders from Zanzibar; then came the German occupation, and in 1905-6 the people rashly took an active part in what is known as the Maji maji rebellion, which was ruthlessly crushed by the Germans, and it is said that some 120,000 natives perished. In the War the area was the scene of desperate fighting between the Germans and the British expeditionary force, all peaceful development being necessarily suspended for the period of this struggle. The Tanganyika administration is, however, now endeavouring to improve the economic condition, but it is a slow and tedious work.

The women of the Mwera, Makonde, and Makua tribes affect an extraordinary ornament called the *pelele*; the upper lip is pierced, the hole is gradually enlarged, and eventually a wooden disc, often as much as two inches in diameter, is inserted and worn. In addition, the lower lip is sometimes pierced and a peg or pin of bone or iron is suspended from it. The origin of this curious custom is not certain, but the coast people assert that it is of recent origin and was done to prevent the women being carried off by the slave traders; for one so mutilated had little value in the slave market. If this explanation is correct, it is curious to find the practice persisting to the present day; this generation will, however, see it disappear. The Yaos never adopted it; their women, however, pierce the side of the nose and insert a stud of wood ornamented with inlaid specks of white metal and called the *chipini*.

Vigorous native communities can only develop where natural conditions are favourable, in an area of natural fertility and abundant water supply. In the whole of the wide strip of bush land behind the east coast of Africa, from Kenya Colony to Portuguese territory, the conditions are very rigorous. The soil is fertile, but the rainfall is exiguous, and the permanent water supplies are scanty; years of drought are more common than seasons of plenty. The people become to some

extent seasonal migrants, and the development of large settled communities is impossible. How can they form large villages when in the dry season it may be necessary for the women of a village to make a journey of two hours to fetch water from a filthy water-hole for cooking and drinking purposes? Little wonder also that, when they are lucky enough to harvest a good crop, they convert too great a proportion into beer, have orgies to celebrate their good fortune, and fail to lay by enough for the inevitable shortage which will ensue. The unhealthiness of the country, moreover, cannot fail to have an unfavourable effect on their vitality, for they are perpetually exposed to the onslaught of the *Anopheles* mosquito; their huts are infected with *Ornithodoros* ticks; the bush is tsetse-ridden; and the stagnant water supplies infect them with intestinal parasites. Even leprosy is not uncommon. These natives are, however, no lower in natural intelligence than those of other portions of Africa, and, when taken out of their squalid surroundings and trained under European influence, they are proved to be capable of considerable mental development; in their homeland their environment weighs them down.

Such is the land in which these wonderful fossil remains occur, and it may be gathered that their detailed exploration is not an easy task or one which can be hurriedly carried out. During the rains the vegetation spreads with great exuberance; foliage appears with a rush, the growth of the grass and the tendrils of creepers being remarkably rapid. The mantle of vegetation is so dense that all prospecting work for new outcrops has to be suspended. In a month or two all this beautiful greenery withers, very soon the grass fires begin, and the scene is changed from one of beauty into a blackened waste. The shade temperature rises to more than 100°, the nights become hotter, so that only hardened, devoted men can maintain their working energy under such arduous conditions.

This picture of the conditions to be encountered is not intended to deter, but to demonstrate that the task of thoroughly investigating this momentous discovery is one which requires the careful organisation of a team of workers, well fed and well looked after, and if possible all anxieties regarding transport and supplies should be taken off the shoulders of the technical staff. In this way results of the utmost value will assuredly be obtained.

### Sex-Determination.

By Dr. F. A. E. CREW.

SEX is the term used to define the differentiation of individuals for the production of dissimilar gametes—the ova and the sperm. A male is an individual efficiently equipped for the elaboration of functional spermatozoa and for the conveyance of these towards the site of fertilisation. A female is an individual equipped for the elaboration of functional ova, for the conveyance of these towards the site of fertilisation, and often also for the transit of the zygote—the fertilised egg—at some stage of its development to the exterior. Associated with these differences in the internal and external reproductive organs there

are others in the general characterisation, the phenotype, by which male and female can be distinguished on inspection. Further, the sexes can be distinguished by differences in the chromosome constitution of the cells of which the individual is built up.

During the process of cell division, changes occur in the nucleus of the cell by which the contained chromatin material resolves itself into a certain number of filaments of definite shape, and these become progressively shorter to assume the form (in many cases) of stout rods—the chromosomes—which arrange themselves on the equator of the spindle. The number of chromosomes

is constant in and characteristic of the species to which the individual belongs. In certain stages of cell activity the chromosomes group themselves to form a characteristic arrangement and it can then be seen that they are associated in pairs, the members of each pair being identical in size and shape.

With the exception of one pair, the chromosome picture is similar in both sexes. In one sex this exceptional pair consists of equal mates, whereas in the other there is one chromosome similar to these, but its mate is either unequal or absent. Since the sexes differ chromosomally in this way, the exceptional chromosomes are referred to as the sex-chromosomes; and of these, those similar in size and shape are known as the X-chromosomes; the unequal mate of the X in the one sex is known as the Y-chromosome. The chromosomes other than the sex-chromosomes are known as the autosomes, and are identical in both sexes. One sex is  $X_o$  or  $XY$ , the other is  $XX$  in sex-chromosome constitution.

It is an established fact that in each gamete—the mature reproductive cell—only one member of each pair of chromosomes is present. In the case of the one sex, each will possess one half set of autosomes and one X-chromosome ( $1A + 1X$ ); in the case of the other sex there will be two kinds of gametes, those that carry  $1A + 1X$  and others that bear  $1A$  alone or  $1A + Y$ . In the mammal it is the male that elaborates two kinds of gametes, the X-bearing and the no-X or Y-bearing, while the female elaborates but one; in the case of the bird it is the female that is hetero- or di-gametic and the male that is homogametic, elaborating but one kind of sperm so far as the elements of the sex-chromosome organisation are concerned. In the case of the mammal an X-bearing egg can be fertilised either by an X-bearing or by a no X-bearing sperm. In the former case an  $XX$  zygote will result having the typical female sex-chromosome constitution, in the latter an  $X_o$  or  $XY$  zygote will result having the typical male sex-chromosome constitution.

It has not only been shown that there are in certain cases demonstrable differences in the chromosome content of the two sorts of gametes elaborated by the heterogametic sex, but also in many mammals, by measuring the length of the sperm-head, it has been shown that there are two intergrading size-classes; it is suggested that the larger sperm is the X-bearing—the female-determining.

The chromosome theory of heredity assumes that all hereditary characters are determined by genes, and that these are resident in the chromosomes, each having its own particular locus in a particular chromosome. The facts that emerge from the study of the mode of inheritance of the so-called sex-linked characters force an adherent to this theory to the conclusion that the genes for such characters are resident upon the X-chromosomes, and that other genes, some on the sex-chromosomes and some on the autosomes, are directly concerned in the determination of the characters maleness and femaleness.

It is an established fact that the heterogametic individual receives its single X-chromosome from its homogametic parent and that the homogametic individual receives one X from each of its parents. If, then, on the single X-chromosome of the heterogametic

individual is borne the gene for a recessive character, it becomes possible to follow the distribution of this X-chromosome by tracing the inheritance of the character. Experimental breeding involving a recessive sex-linked character has shown that, in its transmission from generation to generation, it is bound up in a most intimate way with some mechanism by which the sex of the zygote is determined. A recessive sex-linked character of a heterogametic male will be exhibited by none of his children and by none of his granddaughters but by half of his grandsons; a recessive sex-linked character of a grandmother will be exhibited by none of her children or grandsons, but only by half of her granddaughters.

These facts can most readily and most satisfactorily be interpreted by postulating that the genes for sex-linked characters are resident in the X-chromosomes and also that the X-chromosomes carry genes that are concerned in the determination of sex. The conclusion also emerges that the sex of the zygote is decided by the simplex or the duplex condition of some component which, when present in duplicate, leads to the establishment of femaleness in the mammal and maleness in the bird. The evidence suggests that there is a sex-determining mechanism, an XY mechanism; that the sex-chromosome constitution of the male is  $X_o$  or  $XY$  in the mammal, and  $XX$  in the bird; and that of the female  $XX$  in the mammal and  $X_o$  or  $XY$  in the bird.

In the two sexes the ratio X-chromosomes : autosomes is different, and this suggests that sex determination is not merely an affair of the sex-chromosomes but is also decided by the balance between X-chromosomes and the rest. In the mammals  $2X : 2A$  (where A stands for one complete set of autosomes) is associated with femaleness,  $1X : 2A$  with maleness. This contention finds support in the facts of balanced intersexuality in *Drosophila melanogaster*, in which the ratio  $2X : 2A$  is associated with complete femaleness,  $1X : 2A$  with complete maleness, and  $1X : 1.5A$  with pronounced abnormality in the sexual characterisation.

Since the difference in the sex-chromosomes is the only apparent difference in the genetic constitution of the sexes, it follows that in the mammal the X, or something lodged in it, is female-determining, while male-determination is an affair of the rest of the chromosomes. It is reasonable to assume that maleness and femaleness are characters in the modern Mendelian sense, being based on male-determining (M) and female-determining (F) factors resident in the chromosomes, and that in the mammal the female-determining factors are resident in the X-chromosomes and the male-determining elsewhere. In the bird it must be assumed that in the X-chromosomes are resident the male-determining factors. The situation thus arises that in the mammal,

(FX)(FX)M is an  $XX$  individual, a "determined" or "genotypic" female,

(FX)M is an  $XY$  individual, a "determined" or "genotypic" male,

whilst in the bird

(MX)(MX)F is an  $XX$  individual, a "determined" or "genotypic" male,

(MX)F is an  $XY$  individual, a "determined" or "genotypic" female.

By genotypic is meant according to the genotype—the sum total of the genes in the hereditary constitution of the individual.

At the moment when its sex is determined, the individual is but the fertilised egg. The sexual characters that will define and distinguish it are yet to be expressed. Growth and differentiation precede characterisation, but in the main the characters of the mature individual are simply the expression of the genotype. Before the genotypic male becomes the phenotypic male—an individual equipped to function as the elaborator of sperm—the complicated processes of sexual differentiation must be pursued. It is assumed that these processes are directed by genetic action, that the genes—whatever they may be—elaborate specific chemical substances which model and direct the development of the individual. It is assumed that the sex-determining genes elaborate specific sex-differentiating substances—male-differentiating and female-differentiating respectively—and that these provoke responses especially in the developing structures of the sex-equipment of the individual.

During the development of the mammal there is a period during which the differentiation of the sexual organisation is timed to take place. At the beginning of this period, which follows a preliminary phase of growth and organ formation, the reproductive system consists of (1) paired gonads of indifferent histological structure; (2) a rudimentary accessory sexual apparatus composed of Müllerian and Wolffian ducts; (3) external genital organs represented by the growing urogenital sinus and genital tubercle. From this initial type of reproductive architecture possessed in common by all individuals, determined male and female alike, one or other type of differentiated sexual organisation, male or female, is attained. The indifferent gonads become either testes or ovaries; if they become testes then the Wolffian ducts continue their development to become the functional deferent ducts of the testes, while the further development of the Müllerian ducts ceases and the external genitalia become scrotum and penis. If the indifferent gonads become ovaries, the Müllerian ducts continue their development to become the functional uterus with cornua and vagina, while the development of the Wolffian ducts ceases and the external genitalia assume the form of vulva and clitoris. Sexual differentiation is alternative, and the end-product is an organisation appropriate to the functional female or else to the functional male.

Between the differentiation of the various structures of the sex-equipment there is a time relation. The first structure to begin its differentiation is the gonad. The results of castration and gonad-implantation have shown perfectly clearly that in the mammal the differentiated gonad is necessary for the appropriate differentiation of the rest of the sex-equipment. In the presence of functional testicular tissues, the sexual organisation appropriate to the functional male is assumed; in the presence of functional ovarian tissues, that appropriate to the functional or phenotypic female. Such differentiation is pursued under the control of specific male and female sex-hormones, elaborated by the testis and ovary respectively. It is necessary only to explain the differentiation of the embryonic gonad

in order to explain the complete assumption of the sexual characterisation.

This can be done if it is assumed that the gonad in its indifferent stage is ambivalent as regards its future mode of differentiation (though not completely so since its tissues as regards chromosome constitution are genotypically either male,  $X_o$  or  $XY$ , or female,  $XX$ ), and that this differentiation is pursued under the direction of male-differentiating and female-differentiating substances elaborated by the male-determining and female-determining factors respectively. In the genotypically-determined male,  $(FX)M$ , of the mammal, it is the rule for the male-differentiating substances to be effectively in excess over the female-differentiating substances,  $1F < 1M$ , during that period of development when the differentiation of the gonad is timed to take place, whereas in the genetically determined female, the female-differentiating substances are effectively in excess during this period,  $2F > 1M$ . In the case of the bird the relations of  $M$  and  $F$  are reversed. In the male,  $(MX)(MX)F$ ,  $2M > 1F$ , and in the female,  $(MX)F$ ,  $1M < 1F$ .

As a direct result of genetic action the male becomes possessed of testes, the female of ovaries. The gonads become differentiated and the sex-hormones are liberated. These sex-hormones, testicular or ovarian respectively, reinforce the maleness or the femaleness of the individual and direct the differentiation of the rest of the sex-equipment, as the constituent structures of this attain the appropriate degree of growth and become capable of responding to the stimulus of the appropriate sex-hormone. The genotypic male develops testes because he is a genotypic male: he becomes a phenotypic male because he has developed testes. The genotypic female develops ovaries because she is a genotypic female; she becomes a phenotypic female because she has developed ovaries. In the insect the situation is different. The gonad plays no part in sexual differentiation and the phenotype is based directly on the genotype.

Recent work has shown that the "efficiency" of the sex-determining factors differs in different cases; some elaborate their sex-differentiating substances at a quicker rate than others, or come into action earlier. There are quickly elaborating and relatively slowly elaborating male-determining and female-determining factors. This conception can be illustrated by assigning arbitrary numerical values to these factors.  $M_1$ ,  $M_2$ ,  $M_3$ ,  $M_4$ , and so on, and  $F_1$ ,  $F_2$ ,  $F_3$ ,  $F_4$ , are male-determining and female-determining factors of relatively different efficiencies. Different combinations of such factors are possible. In the mammal a genetic male is an  $XY$  (or  $X_o$ ) individual. On the  $X$ -chromosome are resident the female-determining genes, on other chromosomes are the male-determining genes, symbolised as  $F$  and  $M$  respectively, and these may be  $F_1$  or  $F_5$ ,  $M_1$  or  $M_4$ , according to the genotype of the parent from which each was received.

The situation can thus arise in which in the genotype of such a male there may be a combination of male- and female-determining factors, in which, though in the end  $1M$  would be greater than  $1F$ , yet because the female-determining factors were relatively quickly-elaborating and the male-determining genes relatively

slowly-elaborating ( $F_5$ ,  $M_1$ , for example), the female-differentiating reactions would be in efficient excess during the earlier stages of the period of sexual differentiation. Hence, if the differentiation of the gonads is not a matter of a moment but occupies a certain amount of time, the whole or a part of their differentiation would be pursued under the direction of the female-differentiating reactions and ovarian tissues would be laid down. Later, when the male-differentiating reactions had ultimately overtaken and replaced the female-differentiating, if differentiation is not complete, the rest of the differentiation of the gonads would be into testicular tissues, so that a condition of "glandular" hermaphroditism would result. Since the type of the differentiation of the rest of the sexual characterisation is modelled by the kind of gonadic tissue present, this could lead to a marked degree of hormonal intersexuality.

This conception can accommodate the now established fact of the assumption by a genotypic female of the sexual characterisation of a functional male and vice versa. The sex-chromosome constitution does not necessarily correspond with the sexual characterisation. It is not the sex-chromosomes that finally determine sex; it is the sex-determining gene-complex, and disharmony among the elements of this may be such

as must lead to the assumption of a totally inappropriate sexual characterisation. Further, the situation is created in which environic agencies provoking disharmony can lead to intersexuality and even to sex reversal, which is not the transformation of a female into a male or vice versa, but merely the assumption by an individual genotypically of one sex of the sexual phenotype usually associated with the opposite: genotypically the individual remains unchanged. If sex reversal overtakes an individual of the heterogametic sex, it will continue to elaborate two kinds of gametes even though it functions as an individual of the sex which usually is homogametic, and this fact will be evidenced by the sex-ratio among its offspring. The sexual characterisation of an individual can be classified as (a) *Primary genotypic characters* (the sex-determining factor complex, usually defined by the sex-chromosome constitution, XY or XX). (b) *Secondary genotypic characters* (the sexual phenotype). These include the *Primary gonadic characters* (ovarian or testicular organisation of the gonads). In the insect all the sexual characters are secondary genotypic. In the case of the bird and mammal some are (c) *Secondary gonadic characters* (depending for their expression and maintenance upon the activities of the functional gonads).

### Obituary.

PROF. JAMES WARD.

BY the death of Dr. James Ward, Cambridge has lost one of its most distinguished teachers and British philosophy a man who by general acknowledgment was, along with the late Mr. F. H. Bradley, one of its leading figures. He passed peacefully away on March 4, at the advanced age of eighty-two years, universally beloved and respected, retaining to the end his intellectual vigour, and continuing his work in the University until the illness of his last few days compelled him to desist. The January numbers of *Mind* and the *Hibbert Journal* contain articles from his pen which show that he had lost none of his critical alertness, while two years ago he published an elaborate "Study of Kant," the result of long and sustained research. Until a few months before he died, he was contemplating writing a comprehensive volume on epistemology; as a matter of fact, he had written some chapters of it, a series of articles he contributed to *Mind* during the years 1919 and 1920 constituting one of them.

James Ward was born at Hull on January 27, 1843. The home of his parents was, however, in Liverpool. Here he spent his school-days, and, on their termination, he was articled to a firm of architects. But he soon abandoned the idea of following a business career, and entered Spring Hill College to prepare for the work of the Christian ministry. For a period of twelve months he actually was minister of the Congregational Church at Cambridge. Then he discovered that his theological views were out of accord with those of the members of his congregation, resigned his charge, and entered Trinity College, where he came under the inspiring influence of Henry Sidgwick. He was already a graduate and gold medallist of the University of

London, and was placed alone in the first class in the Moral Sciences Tripos of 1874, being elected a fellow of Trinity in the same year. In his fellowship dissertation on "The Relation of Physiology to Psychology" there can be traced the germs of many of the principles he afterwards worked out in detail.

Ward then proceeded to Germany, where he studied under Lotze at Gottingen and under Ludwig at Leipzig. Of both these teachers he always spoke in terms of the warmest admiration, and there is no doubt he was greatly influenced by Lotze in reaching his own philosophical position. He was appointed lecturer in moral science at Cambridge in 1881. For many years he devoted himself chiefly to psychology, and it was under his guidance that Cambridge gradually became a centre of psychological research. He was instrumental in starting a Psychological Laboratory almost about the same time that Wundt began experimental work in Leipzig. Bringing to the study of psychology a wide and thorough knowledge of biology and physiology, he was enabled to interpret the facts of mind with the aid of evolutionary conceptions in a way that had never before been attempted. Michael Foster used to tell him that he was a "physiologist spoilt"; but he certainly atoned for his desertion of one science by completely revolutionising another.

Croom Robertson was to have written the article on "Psychology" for the ninth edition of the "Encyclopædia Britannica," but was prevented from doing so through failing health. Ward undertook to provide the article; he began writing it in 1884, incorporating the substance of certain papers of his which had already appeared in periodicals, and it was completed in 1885. A supplementary article was prepared by him for the tenth edition of the Encyclopædia in 1885; and finally,

in 1908, these with omissions and additions were amalgamated into the new article of the present or eleventh edition. Probably no article in the "Encyclopædia Britannica" has ever occupied quite the position in the history of a science that this does in the history of psychology. Its original appearance marked the beginning of an altogether new departure in psychological investigation. Ward broke away entirely from the traditions of the associationist school then prevalent in Great Britain; and developed a conception of the mental life that has been immensely fruitful in later psychological work. He propounded a view of the conscious subject as a centre of selective activity that gradually differentiates presentations of the objective world and thus builds up its world of experience. On almost all the main problems of psychology new light was thrown; the treatment of attention, perception, imagination, feeling and conation was essentially fresh and original, and it has entirely superseded the older mechanical method of handling these subjects. It is indicative of the thoroughness with which the foundations were laid that, when a quarter of a century later the work was revised for publication in the form of an independent treatise, little was found of a fundamental nature to alter. The volume entitled "Psychological Principles," which appeared in 1918, contains much additional material, particularly the chapters which deal with the consciousness of self, but the general viewpoint remains unchanged.

In 1897 Dr. Ward was appointed to the chair of mental philosophy and logic at Cambridge. During the previous year he had begun the delivery of a course of Gifford Lectures at Aberdeen, which led to the publication in 1899 of his important work on "Naturalism and Agnosticism." These lectures contain a wonderfully lucid and penetrating analysis of the underlying principles of physical science and a remorseless exposure of the inconsistencies of Herbert Spencer's attempt to base a philosophy of evolution on the principle of the conservation of energy. In the second volume of the book the doctrine of psychophysical parallelism was examined, and it was maintained that the assumption of a dualism between mind and matter renders not only the connexion of body and mind an enigma for the naturalist, but also the problem of the perception of an external world equally intractable to the psychologist. If, then, materialism be abandoned and dualism be dismissed as untenable, there remains only, it was urged, a spiritualistic monism as the one secure philosophical position. The ground was thus prepared for a more constructive effort; and when, ten years later, Prof. Ward was invited to give a further course of Gifford Lectures at St. Andrews, he entered upon the task of trying to determine what we can know, or reasonably believe, concerning the constitution of the world, interpreted throughout and strictly in terms of mind.

The lectures were published in 1911, under the title of "The Realm of Ends, or Pluralism and Theism." The start was made from the consideration that the world immediately confronts us not as one mind, or even as the manifestation of one, but as an objective whole in which a multiplicity of minds are discerned in mutual interaction. From this pluralistic point of view our experience has in fact developed, and from it the ideas

are acquired that eventually lead beyond it. For, though empirically warranted, pluralism, it was argued, turns out to be metaphysically defective and unsatisfactory; it points to a theism which is indeed only an ideal, but an ideal that, as both theoretically and practically rational, may claim our faith though it transcend our knowledge. Ward worked out, in fact, a system of monadology resembling that of Leibniz, except that the doctrine of pre-established harmony was entirely discarded, and the monads were conceived as interacting.

Ward's position in the history of philosophical thought is, beyond a doubt, firmly established. But those who knew him as a friend will be chiefly mindful at this time of his strong and beautiful personality. His wide and accurate scientific knowledge, his love of Nature, and his interest in all that contributes to human good, made him a delightful companion. He could tell the name of every wild flower to be met with in a country walk, the habits of any bird or insect which he chanced to come across; and he would take one back to his home and show with boyish pride the rare collection of birds' eggs he had made in his youthful days. No scholar ever bore his weight of learning more lightly. He would converse, too, when the occasion offered, on the deeper problems of life with the sincerity of a man who was continually wrestling with them, and with a modesty that was engendered by real greatness. Of him his friends can truly feel that of all the men of their time he was of the small company of "the wisest and justest and best."

G. DAWES HICKS.

DR. HEINRICH OSCAR LENZ, the Austrian geographer, whose recent death at Vienna has been announced, was born in 1848. He first went to Africa in 1875 under the auspices of the German Africa Society to make a geological examination of the Lower Ogowe in the Gabun region. In 1879 the same body sent him to Morocco with the view of exploring the valleys of the Atlas. In the face of great difficulties he made a remarkable journey across the Sahara by way of Tarudant, Tenduf, and Arawan to Timbuktu and thence westward through Senegal to the coast. A great part of this journey was over new ground. It was described in his "Timbuktu: Reise durch Marokko" (1884). Lenz's later explorations, which were in the Congo basin, were of less importance. Sent in 1885 by the Vienna Geographical Society to obtain news of Emir Pasha, he ascended the Congo to Nyangwe, and striking eastward reached Lake Tanganyika and Ujiji. The traverse of Africa was completed by Lake Nyassa and the River Shire. For his African work Lenz received the gold medal of the Paris Geographical Society. For some years he was professor of geography at Prague.

WE regret to announce the following deaths:

Dr. André Broca, professor of medical physics in the faculty of medicine of the University of Paris, who was known for his work on physiological optics, on February 23, aged sixty-one.

Dr. William McInnes, formerly director of the Geological Survey of Canada and director of the Victoria Museum, Ottawa, on March 11, aged sixty-seven years.

## Current Topics and Events.

THE British Institute of Philosophical Studies has been formed by a number of professed philosophers together with some leading men of science, public men, and men of affairs. It is the belief of the promoters that philosophy has a larger part to play in the national life than has yet been recognised, both as an education and discipline to the individual, and as the basis of that more synthetic view of knowledge which they take to be the required corrective of the specialism enforced upon students by the rapid growth of science. They think that, in the position which the physical sciences have now reached, the need of a philosophic account of principles and methods is more apparent than it may formerly have been; that there is accordingly more disposition on the part of scientific men to discussions which might, not long ago, have been dismissed as metaphysical; while the philosophers on their side have much to learn of the picture of reality as presented by modern physics. It is considered also that on the side of human relations and social ideals the lack of a common basis is widely felt, and the promoters remember that the systematic exploration of such a basis is a part of the historic task of philosophy. Recognising the existence of an excellent philosophical faculty in the University of London, the Institute will cater specially for the non-academic student, but this does not mean the casual visitant to more or less popular lectures. Lectures with a wide appeal are certainly included in the plan, but the aim is rather to establish systematic courses extending over a considerable period, combining tutorial work or small discussion classes with more formal lectures, and providing for the direction of study, the writing and criticism of essays, and all that may enable a student to make a serious start in his subject. The formation of a good philosophical library is an essential part of the scheme, and it is hoped that the drawing together of a number of philosophers, who are at present a somewhat lonely race, to co-operate in the advancement of their subject, may prove a stimulus and encouragement to original work, with which it is hoped that the Institute may be associated.

IN 1892 Dr. John Hopkinson, in his presidential address to the Junior Institution of Engineers, laid down the principles on which an equitable method of charging for the electric light could be devised. Probably no subject has been more discussed by electrical engineers than his method of charging, and numerous modifications of it have been tried in practice. At the Institution of Electrical Engineers, on April 2, G. Wilkinson and R. McCourt read a paper describing a novel modification of Hopkinson's principle, that each consumer should bear his proportion of the cost of the standing charges as well as the cost of the number of units he uses. In several cities a two-part tariff is employed, which consists of a fixed charge based on the rateable value of the premises, and in addition a low price per unit for all the electricity used. The obvious criticism to this system is that the assessment of the building for

rating purposes does not necessarily bear any relation to the consumer's demand. The authors propose that each consumer should fix his own maximum demand for electrical energy. So long as this maximum demand is not exceeded, then, if his consumption during the quarter exceeds a definite number of units, all units in excess of this amount would be charged for at a merely nominal rate. On the other hand, if he ever exceeded his "maximum demand," all units expended during the time of overload would be charged for at the full rate. A simple meter was described which records the charge automatically on a high-rate and a low-rate dial. When a consumer was exceeding his demand one or more neon lamps fixed in suitable places were illuminated so that he knew that he was paying at the higher rate. The system is, in our opinion, fairly equitable, but we think that most consumers would have a difficulty in understanding it and would have a suspicion that advantage was being taken of their ignorance.

IN the discussion on the financial resolution in connexion with the Imperial Institute Bill which took place in the House of Commons on March 30, it was stated by a member that little appeared to have been heard of the actual work of the Institute. It is therefore appropriate to direct attention to the principal publication of the Institute, namely, its quarterly Bulletin, which has now reached its twenty-third year of issue. Each number of this quarterly contains results of investigations conducted in the laboratories of the Institute, articles and notes on the production and utilisation of Colonial and other raw materials, a summary of recent progress in agriculture and the development of natural resources, and notices of recent books dealing with such subjects. In the number of the Bulletin just issued (vol. 23, No. 1) a new feature has been introduced consisting of a classified bibliography relating to Colonial development and resources. This section should prove of great value to workers overseas. The investigations at the Institute recorded in the present issue include the examination of the berries of a South African tree which yields an oil shown to be suitable for soap-making; the determination of the properties of balsa wood from British Honduras and monkey apple timber from Sierra Leone and a study of their possible uses; and an investigation of certain British Honduras woods as paper-making materials. A third instalment of an article on the possibilities of cement manufacture in the Crown Colonies and Protectorates contains incidentally the results of examination at the Institute of various cement-making materials from Trinidad, the Bahamas, British Honduras, and Fiji. An article giving an account of the henequen or Mexican sisal hemp industry of Yucatan should prove of interest to planters in Kenya, Tanganyika, and other parts of the British Empire where the production of sisal hemp is of increasing importance.

THE arrangement of the Science Exhibition in the Government Pavilion at the British Empire Exhi-

tion, at Wembley, is this year in the hands of a Royal Society committee under the chairmanship of Mr. F. E. Smith. The theme of the principal section of the physical exhibits is the subject of radiation and wave motion; and the extended spectrum of electromagnetic oscillations and radiations, from slow oscillations and wireless waves at one end, through the visible region, to X-rays and  $\gamma$  rays at the other, has been taken as the basis of arrangement. The exhibits will show the methods of generation and detection of radiation in the different regions and will illustrate the properties of the rays; and the essential correspondencies will be emphasised, e.g. selective absorption of visible rays will be compared with resonance and the tuned circuit in the wireless region. A very large proportion of the exhibits will be working demonstrations. Space will also be devoted to the work on atomic structure, where the exhibits will include models of the atoms. Meteorology, terrestrial magnetism, and seismology will again be represented, and a working seismograph will be shown. The arrangement of the sections of zoology, botany, and physiology will follow rather similar lines to that of last year, where the exhibits having a bearing on evolutionary theory were found to be extremely popular. A revised edition of the Handbook is to be published, which will contain an introductory article by Sir Oliver Lodge. Other new articles are by Prof. G. Elliot Smith on "The Human Brain," Mr. C. Tate Regan on "Darwinism," and Dr. E. J. Allen on "Life in the Sea."

In our issue of February 21, p. 276, we referred to the system of loan collections which is in operation at the Salford Museum and also at the American Museum of Natural History. Such a scheme, we learn, has for twelve years been the basis of the "Lending Department" of the Newark Museum, Newark, New Jersey. Born and raised in a public library building, this museum has adopted many of the ways of the modern library. This has been all the easier as its Director, John Cotton Dana, is also City Librarian. The Lending Department of the Museum, although open to the general public, is used almost entirely by the schools. Its collections number more than 5000 objects, classified under 28 heads, of which the most important are life and customs, geographical, dolls in costume, and industrial process charts. Science and nature study are also well represented. Descriptive and illustrated matter accompanies most of the exhibits, which are made up according to requests and delivered to the schools three times a week—about 1500 objects a month. During 1924 more than 500 teachers in fifty out of seventy public schools used this Department. The Museum's collections thus came under the eyes and hands of more than 30,000 children—most of them between the ages of nine and twelve, and representing a dozen different races. Borrowing has been made as simple as in the library, and most of the objects may be kept for one month, with privilege of renewal. The popularity of this Department is the more notable because the Newark Museum is within an hour's ride

of the great museums and collections of New York City.

THE services of preparators and laboratory attendants do not always meet with the recognition they merit. It is therefore pleasing to note that the cross of the Légion d'honneur has been conferred on M. Henri Vigreux, "garçon de laboratoire" at the Paris Faculty of Sciences. M. Vigreux, who entered the service of the Sorbonne in 1895, suffered severely from the bursting of an apparatus for fractional distillation in 1898. He set himself then to improve the apparatus of the chemical laboratories and became highly expert in glass-blowing, inventing many pieces of apparatus and many methods of great value to chemists and physicists. In 1919, having lost the left forefinger in another explosion, he travelled round the laboratories of the provincial universities teaching the craft of working in glass. M. Vigreux has previously received the silver medal of the Société d'encouragement pour l'industrie nationale and the "grand-prix" of a recent exposition of craftsmanship.

NEARLY two years ago, complaint was made before the Intellectual Co-operation Committee of the League of Nations at Geneva that the Vienna Academy of Sciences was so impoverished as to be unable to publish its transactions. At about the same date, extensive abstracts of its papers were published by *Die Naturwissenschaften* at Berlin. For a year past NATURE has reported at least the titles of papers read. These have been taken from the *Anzeiger* pamphlets reporting each meeting. The complete volume of *Anzeiger* for the year is now to hand. (Akademie der Wissenschaften in Wien. Mathematisch-naturwissenschaftliche Klasse. *Anzeiger* 61. Jahrgang 1924, Nr. 1 bis 27, pp. 209. Holder, Pichler, Tempsky. Wien, 1925.) It will be valued as giving in a collected form reports which have been scattered through a number of small continued contributions. Such are the reports from the Handel-Mazzetti botanical expedition to China, the reports of the Radium Institut and the meteorological reports.

THE February weather map of the Dominion of Canada records some unusual features for the month. In all Ontario the mean temperatures were in excess of the normal, by 6°-10° F. in the region of the lower lakes and the Ottawa valley. The province of Quebec had the mildest February since 1877, and in many parts the ground was nearly bare of snow at the close of the month. In the maritime provinces last February was one of the mildest on record, with little or no wintry conditions after the first week. In many parts the thin covering of snow on bare ground seriously delayed lumbering operations. In the prairie provinces and British Columbia the month was milder than usual, except to the north of the fifty-fifth parallel, where the mean temperature was considerably below normal. In the Yukon there was a deficiency of 8°-10°. Precipitation was generally deficient except in Quebec, part of southern Ontario, Vancouver Island, and the lower Fraser valley.

UNTIL further notice the Science Library, South Kensington, will remain open until 8 P.M. on Thursdays and Saturdays. After 6 P.M., entrance to the Library will be through the Imperial College of Science and Technology in Imperial Institute Road.

At the meeting of the London Mathematical Society, to be held on April 23 at 5 P.M., in the rooms of the Royal Astronomical Society in Burlington House, Dr. Harold Jeffreys will give a lecture on "The Interior of the Earth." Members of other scientific societies will be welcome.

DR. F. W. ASTON, fellow of Trinity College, Cambridge, has been elected a member of the Athenæum under the provisions of the rule of the club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public service.

APPLICATIONS for grants in aid of scientific investigations bearing on agriculture to be carried out in England and Wales are invited by the Ministry of Agriculture and Fisheries. They must be made upon a prescribed form (A. 53/TG) obtainable from the Secretary to the Ministry, Whitehall Place, S.W.1.

THE fourth course of training of seed analysts will be held in the summer of 1925, beginning on July 7, at the Official Seed Testing Station, Cambridge. Particulars of the course can be obtained from the Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

A JOINT general discussion on "The Physical Chemistry of Steel-making Processes" is to be held by the Iron and Steel Institute and the Faraday Society on Monday, June 8, at the Institution of Civil Engineers, Great George Street, London, S.W.1. Sir Robert Hadfield, Bart., will deliver the introductory address, and a provisional programme of papers covering the various phases of the manufacture of steel has been issued.

PROVIDED works of sufficient merit are submitted, the second award of the Nichols prize of the Royal Society of Medicine, value 250*l.*, will be made in 1927. The prize is open to British subjects for the most valuable contribution towards "The discovery of the causes and the prevention of death in childbirth from septicæmia." Competing essays must be typed or printed in English, accompanied by the names and addresses of the authors, and be submitted not later than October 1, 1927, to the Secretary, Royal Society of Medicine, 1 Wimpole Street, W.1.

IN our issue of January 17, p. 96, we expressed regret that such an old-established firm of optical instrument makers as that of Sir Howard Grubb and Sons, Ltd., of St. Albans, should have gone into voluntary liquidation. We are glad now to learn from Sir Charles A. Parsons that a new company, trading as Sir Howard Grubb, Parsons and Co., has purchased from the liquidator the goodwill, drawings, and sundry plant and machinery of the firm, and that

workshops of up-to-date design are being erected at Heaton, Newcastle-on-Tyne, especially suitable for the building of large astronomical telescopes and observatory equipment. The advice and experience of Sir Howard Grubb will be at the disposal of the new company. All communications should be addressed to Heaton Works, Newcastle-on-Tyne.

THE Smoke Abatement League of Great Britain held a Conference in the Town Hall, Manchester, on November 3-6, 1924, at which a series of papers was read by persons interested. The papers and discussions have now been published in a handy volume (5*s.* 6*d.* post free) to be obtained from the Secretary, C. Elliot, 33 Blackfriars Street, Manchester. This symposium covers practically every aspect of the subject; the law and smoke; the measurement of air pollution; the effect of smoke on human life, vegetation, and buildings; smokeless fuels prepared by low and high temperature carbonisation; steam generation; electrical power supply; and lastly, the economic aspect of a smoky atmosphere. Looking through the papers one is struck by the very diverse remedies prescribed by the advocates of different processes, and a general consensus can scarcely be obtained. Doubtless all will contribute a share, and the publication is certainly of value as bringing to a focus the many ideas which are expected to lighten the darkness of our industrial cities.

THE report of the National Physical Laboratory for the year 1924 is a quarto volume of 220 pages, 170 of which are devoted to accounts of the researches which are at present in progress in the Laboratory. These accounts are as a rule sufficiently detailed to allow the reader to understand the object of the research, the method adopted and the results which so far have been obtained. They are accompanied by illustrations which add considerably to their interest and their value. So far as the amount of testing work done during the year is concerned, there has been an increase since the previous year in all departments except those connected with engineering and shipbuilding. The need of new buildings for physics and electrotechnics has again been pressed by the Committee, and it is hoped that funds for them will be forthcoming at an early date. A large proportion of the research work is undertaken for the Research Associations of the Department of Scientific and Industrial Research and for other Government Departments, and the rest is under the control of Sir Joseph Thomson, Sir Ernest Rutherford and Sir William Bragg, who visit the Laboratory from time to time.

THE after-Easter lecture session at the Royal Institution will commence on Tuesday, April 21, at 5.15, when Prof. J. Barcroft will begin a course of four lectures on "Some Effects of Climate on the Circulation." The Tyndall lectures will be delivered by Prof. R. Whiddington on the passage of electricity through vacuum tubes, commencing on Tuesday, May 19. On Thursday afternoon, April 23, Mr. F. Kingdon Ward will begin a course of two lectures

on exploration in Tibet. On succeeding Thursday afternoons there will be two lectures by Prof. H. J. Fleure on prehistoric trade and traders on the west coasts of Europe, and two by Prof. F. O. Bower on the natural classification of ferns as a study in evolution. Mr. W. P. Pyecraft is to give two Saturday afternoon lectures on use and disuse and their effect on the bodily structure of animals. The Friday evening meetings will be resumed on April 24, when Dr. W. A. Craigie will deliver a discourse on the Icelandic Sagas. Succeeding discourses will probably be given by Prof. W. L. Bragg, Dr. H. H. Dale, Prof. C. G. Darwin, Dr. Thorne M. Carpenter, Sir Henry Newbolt, and others.

MESSRS. Negretti and Zambra, 38 Holborn Viaduct, London, E.C.1, have issued a useful list of second-hand and shop-soiled instruments which they have for disposal. The list contains, among other items, a useful selection of microscopes, pieces of surveying apparatus, and thermometers, while under "sundries" are offered projectors, barographs, aneroids, and so on. The list should be seen by all who are contemplating the purchase of apparatus.

A VERY full and comprehensive catalogue (No. 125) of second-hand botanical works has just reached us from Messrs. Dulau and Co., Ltd., 34 Margaret Street, W.1. It contains 4439 titles conveniently arranged in the following sections: Regional Floras, Gardening and Horticulture, Fruit Culture, Sylviculture, Gardens and Landscape Gardening, Biology of Plants, Monographs, Biography, Bibliography, Terminology, Dictionaries, Manuals, etc., Herbals and Early Gardening, Cryptogamic Botany, Phyto-pathology, Geoponica, and Serial Publications.

THE Cambridge University Press will shortly publish Vol. 19 of the Royal Society's "Catalogue of Scientific Papers," covering the letters T to Z and completing the work. Another book to be issued by the same house will be "Aerial Surveying by Rapid Methods," by Prof. B. Melville Jones, the main purpose of which is to discuss the possibilities of aerial photography as a means of surveying and mapping the earth, and to record and describe a series of experiments made at Cambridge by the author and the late Capt. J. C. Griffiths.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: a guide-lecturer in agriculture at the British Empire Exhibition—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (April 25); an assistant lecturer in agriculture at the Agricultural Institute, Kirton, near Boston, Lincs.—J. C. Wallace, at the Institute (April 30); demonstrators in physics and organic chemistry respectively, at Bedford College for Women, Regent's Park, N.W.1—The Secretary (May 2); three assistant naturalists in the fisheries department of the Ministry of Agriculture and Fisheries—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (May 8); a woman lecturer in geography in the department of education of the University, Birmingham—The Secretary (May 16); assistant professor of zoology in McGill University, Montreal—The Secretary (May 20); an assistant professor of chemistry, of Egyptian nationality, at the Cairo School of Medicine—The Director (May 31).

ERRATUM.—In NATURE of April 4, p. 518, col. 1, line 14, the name of Mr. Savin is printed incorrectly as Sairn.

### Our Astronomical Column.

A SIMPLE INTERFEROMETER. — Probably many people are under the impression that interferometer methods are only possible with very large instruments. This is undoubtedly the case where measurement of stellar diameters is in question. But a short paper by Mr. L. Richardson (Brit. Astron. Assoc. Journ., Feb. 25) describes an application of the method that is within the reach of all amateurs. This is a cardboard screen covering the object-glass with a number of parallel openings cut in it, the width of the closed spaces being made equal to that of the open ones. The card can be turned by strings from the eye-end about an axis in its own plane through its centre, and the amount of tilt read on a scale made of millimetre paper. Each star then shows a central image, and a series of diffraction images on each side diminishing in brightness. Turning on Castor (for example), the card is tilted until the distance between the principal and first diffraction image is equal to that between the two stars of the binary. The tilt of the card then gives a very good measure of the angular distance between the stars. Four measures of Castor give distances 4.57", 4.56", 4.54", 4.59". Since the images are short spectra, there is a liability to personality in the measures, but a single observer can obtain accurate relative results.

THE NEW WASHINGTON CATALOGUE OF FUNDAMENTAL STARS.—Prof. W. S. Eichelberger com-

municates to *Ast. Nach.* No. 5353 a paper on this catalogue, which will appear in full in vol. 10 of "Papers of the American Ephemeris," a summary of results being given in the Ephemeris for 1925. It uses the results of two observatories only (the Cape and Washington); the Cape declinations are corrected by  $-0.15''$  tan zenith-distance-north, as a result of a rediscussion of refraction. The general result of the discussion is that the declinations in Boss P.G.C. need a nearly constant correction of about  $+0.47''$  from  $50^\circ$  N. Decl. to  $40^\circ$  S. Decl.

Prof. Eichelberger then turns to the new Greenwich catalogue for 1925 and notes that, while on the published figures it agrees better with Auwers than with the new Washington one, yet if two changes were made, (1) the use of his new proper motions in bringing up to 1925, (2) giving Venus equal weight with the sun in fixing the equator point, the Greenwich and Washington results would not differ much.

The errors in Boss's proper motions are ascribed to uncorrected systematic errors in the older catalogues that he employed. In the future it will probably be desirable to discard, at least for fundamental stars, all catalogues that rest on observations with instruments the division errors, etc., of which were not determined by modern methods.

## Research Items.

**SEX RATIOS IN AFRICA.**—Capt. L. W. G. Malcolm has brought together in the *American Anthropologist*, vol. 26, No. 4, data from various sources, in addition to his own observations, bearing upon the question of sex ratios among the tribes of West Africa and other parts of that continent, with the view of ascertaining what relationship these ratios bear to racial decline or otherwise. In the case of the adult sex ratio there is, in the majority of cases, a low degree of masculinity. The preponderance of females over males, however, in many cases is due purely to artificial causes, such as intertribal warfare and slavery or forced labour, which have depopulated large tracts, especially in West Africa. The ratio is 89.80. For the sex ratio at birth the information is very scanty; but it appears to be somewhat lower than that of European countries. The suggestion that a surplusage of adult men over adult women of reproductive age is consistent with a corresponding decline in the crude population, and that an increasing population produces a surplusage of women, does not appear to be in accord with the observed facts. The evidence for Africa is too scanty to indicate whether there is a higher proportion of male to female births in polygamous or monogamous marriages. An appended note by Dr. A. S. Parkes suggests that the great excess of females among adults is produced by a high masculinity in the mortality, possibly due to an inherent frailty of males which is also apparent in European figures.

**PLANKTON at CULLERCOATS.**—Plankton investigations occupy a large part of the report for 1923–24 of the Dove Marine Laboratory, Cullercoats, Northumberland, each group being dealt with both in the form of lists and tables. With such an amount of information available, the plankton of the Cullercoats area should soon be thoroughly known. Miss Jorgensen states in her report on the Crustacea that, whereas there are many more decapod larvæ taken from the inshore stations, the copepods were in much larger numbers farther out. In her table, however, showing total copepods, she gives the largest average but one from Station I., which is one of those closest inshore. On carefully examining the detailed copepod tables, we find that this inshore maximum is chiefly due to Temora, a neritic copepod capable of living under very variable conditions. The bulk of Miss Meek's important work on pollution of the River Tyne is reserved for a separate memoir, only a short résumé appearing here in which she states that last autumn there was a good ascent of salmon, and the smolts passing to the sea in the spring were numerous, few having died in passing through the polluted area.

**CHENOPODIUM OIL IN THE TREATMENT OF HOOKWORM.**—In the *Journal of Pharmacology and Experimental Therapeutics* for December 1924, Drs. W. G. Smillie and S. B. Pessoa give an account of the anthelmintic properties of the various components of chenopodium oil, one of the drugs authorised by the International Health Board for use in campaigns against hookworm disease. The constituents of the oil were isolated for these experiments at the Wellcome Chemical Research Laboratories in London, and the authors show that the only vermifugal agent in the oil is ascaridole, which proved to be remarkably efficient against the two common forms of hookworm, *Ankylostoma duodenale* and *Necator americanus*, though the latter was more susceptible to its action than the former. Victims of hookworm disease in the tropics almost invariably harbour other helminths,

notably *Ascaris*, in addition to hookworm, and ascaridole has the advantage over other hookworm remedies, such as thymol and carbon tetrachloride, of also eliminating *Ascaris* from the intestinal canal. In view of these results, the authors point out that if ascaridole itself proves too expensive for use in extensive campaigns against hookworm and it is necessary to resort to chenopodium oil, it is desirable that the dosage of the oil should be based on the amount of ascaridole in it. If this precaution were taken, much of the risk attending the use of chenopodium oil, which like all effective anthelmintics is toxic to the host as well as the parasite, will be avoided. The authors naturally do not refer to other remedies for hookworm, but there is now a considerable amount of evidence that a solution of ascaridole in pure carbon tetrachloride is probably the most effective remedy against joint infection by hookworm and *Ascaris*. It has the great advantage of being cheap, a point of first-rate importance in such campaigns where the cases to be treated are numbered by hundreds of thousands.

**THE LEPIDOPTERA OF NEW YORK.**—Memoir 68 of the Cornell University Agricultural Experiment Station (June 1923) has recently come to hand, and is devoted to an account of the "Lepidoptera of New York and Neighboring States." The author, Mr. W. T. M. Forbes, is to be congratulated upon this very careful and detailed piece of monographic work. It extends to more than 700 pages, and deals with all the so-called Microlepidoptera and such families as the Saturniidae, Bombycidae, and Lasiocampidae, etc., among the higher groups. It is, furthermore, prefaced by a good illustrated general account of the external morphology of the order. The wealth of information relating to family, generic and specific characters and the metamorphoses should prove of great value to the systematist, while at the end of the memoir there is a good index to the food-plants of all the larvæ referred to. We shall welcome the appearance of the remaining portion of this work, which, when completed, will serve as a general book for reference.

**SEX-TRANSITION IN PLANTS.**—*Arisæma japonica* is an Aroid which has usually been regarded as strictly dioecious, although American species may be monoecious. Tokujiro Maekawa (*Journ. Coll. Agric., Imp. Univ. Sapporo, Japan*, vol. 13, Part 3), in an interesting account of experiments with this plant, shows that the same corm is at first asexual, after one or more years develops a male inflorescence, and one or two years later becomes (and normally continues) female. The author collected 231 corms from which he demonstrated these phenomena of sex-transition. Occasionally retro-transition from female to male took place, but monoecious inflorescences were rare and intersex conditions apparently did not occur. Sex is here a progressive phenomenon in the individual correlated with the weight of the bulb, and believed to be dependent on the amount of formative assimilation products (*i.e.* size of leaves) rather than the amount of reserve material in the corm. It was possible to reverse the sex of a female corm by growing it in poor, sandy soil or by cutting off portions of the corm or leaves. In this way a corm which had been producing female inflorescences could be made to produce a male. The relation of these results to other studies of sex-determination in plants is discussed at some length. Schaffner (*Amer. Journ. Bot.*, vol. 9, p. 72) has obtained similar results with American species of *Arisæmas*.

**BROWN HEART IN AUSTRALIAN APPLES.**—Reports 21 and 22 of the Food Investigation Board of the Department of Scientific and Industrial Research seem to show conclusively that this diseased condition of imported Australian apples results from the accumulation of carbon dioxide in the ship's hold during the voyage (see NATURE, vol. 112, pp. 636-7, October 27, 1923). Report 21 gives the results of the study of the atmosphere in ships' holds during the voyage by Messrs. A. J. Smith, Ezer Griffiths, and E. A. Griffiths. In Report 22, Mr. A. J. Smith, the physiologist sent out by the Food Investigation Board to Australia, presents the results of his investigations of conditions in the orchard and during the handling of the apples up to the time of shipment. No signs of brown heart were discovered in the fruit prior to shipment, nor was the treatment of the fruit likely to produce the disease. On the other hand, the concentration of carbon dioxide in unventilated ships' holds often rose above the safety limit of 10 per cent. during the voyage, and shipments examined on arrival showed marked correlation between occurrence of brown heart and high carbon dioxide contents recorded on the voyage.

**A NEW DEVONIAN ECHINOID.**—A new genus of echinoid (*Nortonechinus*) from the Upper Devonian of Iowa is described by A. O. Thomas (Iowa Geol. Survey, 19, p. 481). The genus shows several features of interest, and the great rarity of echinoids in the Devonian system gives importance to this discovery. *Nortonechinus* appears to be allied to *Archæocidaris*, but differs from it in having 11, or possibly 14, columns of plates in each interambulacral area instead of 4; and the imbrication of the plates is more considerable, so that the test must have been very flexible. The spines are remarkable for the great expansion of their distal ends, so that they became polygonal by mutual contact, and must have formed a coat of mail over the test similar to that seen in the living species *Colobocentrotus atratus*; this feature has been hitherto unknown in Palæozoic echinoids except to a limited extent in *Xenocidaris*. Parts of the lantern have been found and seem to be similar to those of modern cidarids.

**THE GEOLOGY OF SOUTHERN RHODESIA.**—A very valuable summary by H. B. Maufe of the physical features and geological formations of Southern Rhodesia appears in the first "Official Year-book" of the Colony, and is conveniently reprinted as a Short Report (No. 17) of the Geological Survey. The report is accompanied by an excellent colour-printed geological map, and the history of the region is well set forth in a provisional table of formations which also gives the associated igneous intrusions, earth-movements, and economic minerals. Unfortunately no fossils have been found in any beds older than those of the Karoo system. Even where fossils do occur, they are wholly terrestrial, the sea never having invaded the Colony since at least Carboniferous times. The *Glossopteris* flora is represented in the Wankie coalfield, while the Upper Karoo has yielded remains of dinosaurs and of petrified wood. The younger Kalahari contains freshwater shells and the plant *Chara*. The older rocks can be correlated lithologically with corresponding systems in South Africa, but in neither area has it yet proved possible to correlate with standard equivalents elsewhere. The discovery of uranium minerals would probably help in determining the position of one or two of the unfossiliferous formations. Already, indeed, the uraninites of Morogoro and Katanga may be used in this way. They are clearly of Upper pre-Cambrian age, and if the lithological correlations can be trusted, the Transvaal

System (sometimes thought to be Ordovician from the occurrence of a doubtful fossil in Angola) should be, as Prof. J. W. Gregory thinks, nearly equivalent to the Torridonian or Longmyndian in Britain.

**PRECAUTIONS AGAINST TROPICAL CYCLONES.**—The recent quarterly number of *Matériaux pour l'Étude des Calamités* contains an important article by Mr. Stephen S. Visser on tropical cyclones as calamities (No. 3, 1924, pp. 195-217). Most of it is devoted to a description of typhoons, their principal centres of origin, their seasonal distribution and frequency, and the courses followed by typhoons. In the concluding pages, he suggests several methods of reducing the damage done by them. Houses should be built of reinforced concrete and about twenty feet above the sea-level or the bottom of a valley. Coastal cities should be protected from hurricane waves by sea walls like that at Galveston, U.S., where six thousand lives were lost during a typhoon in 1900. Crops should be diversified, so that all is not necessarily lost at one blow. The taller growing varieties of bananas should be replaced by the dwarfed Chinese kind, and indiarubber plantations should be grown in sheltered valleys. Weather offices should be established in the stormier regions, so that sufficient notice of an approaching typhoon may be given by radio or telegraph to allow the strengthening of buildings or the removal of livestock and boats from the lowlands.

**TEMPERATURE RECORDS AT WILLIS ISLAND.**—We have received from Capt. E. Kidson, of the Meteorological Bureau of the Commonwealth of Australia, a note on a paper on "Observations from the Willis Island Meteorological Station" which was read at the meeting of the Australasian Association for the Advancement of Science in Adelaide in August 1924, together with copies of two weekly thermograph charts. The island offers useful opportunities for research into the meteorology of the trade winds, being in lat. 16° 18' S. and long. 149° 58' E., 250 miles from the mainland of Australia. The island is only about 600 yards by 250 yards at low water, and is less than 30 feet above low-water mark. It might thus be expected that the diurnal range should be one or two degrees only as over the ocean, instead of which the thermographs show frequently ranges of so much as 8° F. The thermograph is fitted in a Stevenson screen, which is fixed on a base of concrete. Dr. Kidson throws doubt on the efficiency of the Stevenson screen, but it is certain that the effect of the base of concrete must be very considerable. The cooling effect of showers of rain would appear to confirm this. In view of the ideal location of the island, it is highly desirable that observations should be taken there by means of properly ventilated instruments.

**SOUND AND WIRELESS IN HYDROGRAPHY.**—As a result of the extensive series of measurements of the speed of sound in sea water undertaken by the United States Coast and Geodetic Survey, the steamer *Guide* has been equipped with a special sound and wireless method of determining its position at sea during a hydrographical survey it is making of the coast of California. The equipment is described by Commander N. H. Heck and Messrs. E. A. Eckhardt and M. Keiser, of the Bureau of Standards, in Special Publication No. 107 of the Survey. A bomb of T.N.T. is fired under-water by the ship and the sound wave is picked up by three shore stations provided with hydrophones. Each hydrophone by means of a relay sends out a wireless signal which is received by the ship. The interval between the firing of the

bomb and the reception of the wireless signal is recorded automatically on a chronograph, and from the records for the three stations the position of the ship is determined. Full particulars of the apparatus are given in the paper, and it has been found to give results as accurate as visual methods, and to be applicable during fog and rough weather when these methods are no longer of use.

**ATOMIC COMBINATION AND THE QUANTUM THEORY.**—Messrs. M. Born and J. Franck, in the *Zeitschrift für Physik* of February 19, show that according to the quantum theory a stable molecule cannot be formed by the simple collision of two atoms, but that a triple collision is necessary, the third particle serving to carry off the excess of energy. In spite of this it is shown that molecules which are not fully quantified (quasi-molecules) may be formed, and that they may exist long enough to emit or absorb characteristic radiations which can be recognised in the spectrum of a gas. When two atoms collide they move round their common centre of gravity in cometary orbits, and during a certain period their trajectories are not very different from those of the atoms of a stable molecule. During this period it is possible for the quasi-molecule to be excited, an electron jumping into a higher quantum orbit; if this then falls back into the lower orbit, the quasi-molecule will emit a characteristic radiation. In a similar manner characteristic absorption phenomena will be produced, absorption bands being formed without any structure due to rotational quantification and others where the signs of vibrational quantification (band groups) are weak. A number of spectra can be explained in this way, particularly certain appearances in the spectra of metallic vapours.

**EÖTVÖS TORSION BALANCE.**—An improved model of the Eötvös torsion balance has recently been put on the market by Messrs. L. Oertling, Ltd. Hitherto visual observations in this type of instrument have necessitated the provision of long brackets to carry the observing telescopes, so that a large and heavy tent has been necessary for the protection of the balance. In the new Oertling model, telescope arms are completely eliminated so that the effective width of the instrument is reduced considerably. This balance can be used either for visual reading or photographic self-recording, the change from one system to the other being possible by simply replacing a ground glass screen by a photographic dark slide. The rotation of the upper part of the instrument into various azimuth positions is effected by a clockwork mechanism controlled by an electric time clock, which also controls the illumination of the scales at the proper intervals, and moves the photographic plate. A special optical system enables a magnified image of the actual scale to be observed or photographed, while the sensitivity is also increased and is variable at will. The spaces between the three metallic walls of the balance are packed with special insulating materials, while additional protection is provided by a three-walled cylindrical tent, the inter-wall spaces of which are also packed. Arrangements are provided by means of which it is possible to read the instrument from outside the tent, through specially placed windows, so that it is unnecessary to open the tent door after the instrument has once been set up. In this way it is claimed that temperature and radiation effects are reduced to an absolute minimum consistent with economical transport, while it is confidently anticipated that readings can be taken both by day and by night, and at least three stations occupied every twenty-four hours. Other modifica-

tions are introduced, among which may be mentioned the clamping of the balance to the tent after observations have been completed, enabling the instrument and tent to be moved together as a whole to the next station, after which the instrument is unclamped and relevelled, when it is immediately ready for use again.

**THE LIMITING POSSIBILITIES IN STEAM PLANTS.**—An examination of the available evidence and the fundamental facts in searching for the real upper limits to the sequence of operations in steam plants provided the subject matter for an interesting paper read by Profs. A. L. Mellanby and William Kerr before the North-east Coast Institution of Engineers and Shipbuilders on February 27. The paper opens with a discussion of the temperature limits, obviously a question of the properties of the materials employed. The results of direct stress and fluctuating stress researches, together with creep-limit considerations, demonstrate an upper limit of 750° F. to 800° F. for the ordinary steels and the best non-ferrous metals. With special steels, and allowing the possibility of fair advance to the metallurgist, the authors consider that 900° F. represents the steam-plant limit. The consideration of pressure limits is one of thermal efficiencies, and a critical survey of the factors involved indicates 1250 lb. per square inch as the limiting pressure above which no gain need be expected, although it appears that there is too little prospective gain to justify actual advance beyond 1000 lb. per sq. inch. Discussing reheating, the authors consider that two stages of reheating requiring a total heat supply of between 40 and 50 per cent. of the Rankine heat drop provide the true limit to the reheating process. This condition is closely met by reheating pressures of 500 and 180 lb. per sq. inch. The best feed-heating limits are obtained by choosing eight heaters operating on the range up to the saturation temperature corresponding to 1000 lb. per sq. inch. The limiting cycle thus starts from initial conditions of 900° F. and 1250 lb. per sq. inch, involves re-superheating at intermediate pressures of 500 and 180 lb. per sq. inch, and includes the employment of about eight extraction feed heaters, equally stepped, on a range of liquid heats up to that corresponding to 1000 lb. per sq. inch pressure.

**SULPHIDE FOG PRODUCED BY BACTERIA.**—The Eastman Kodak Company of Rochester, N.Y., found that 65 gallons of metol-hydroquinone developer, used in a tank for developing motion picture negative film, suddenly began to give excessive fog. Similar cases were observed when developer in a deep tank after a certain amount of use was at rest, unused, for at least two or three days, or when a smaller quantity was kept in a closed bottle. Messrs. M. L. Dundon and J. I. Crabtree (*British Journal of Photography*, p. 172) investigated the trouble, and found sulphides in such developers either in solution or in the sediment. It has been shown that some bacteria are able to reduce thiosulphates, sulphites, and even sulphates to sulphides, and the authors confirmed the action with ordinary yeast. Bacteria were found in the faulty developers, "bacilli predominating although cocci were present." Such developers may be restored to good condition by adding about 0.5 gm. of lead acetate per litre to precipitate the sulphide. When a developer is used continuously, the dissolved silver salt precipitates the sulphide as it is formed, and the authors found that silver bromide was sufficiently soluble in the developer for this purpose. No substance has yet been found that can be recommended as a preservative against bacterial growth in a developer.

### The Fifth Washington Meeting of the American Association for the Advancement of Science.

THE fifth Washington meeting of the American Association for the Advancement of Science was held during convocation week, December 29, 1924-January 3, 1925. This meeting was one of the larger, quadrennial meetings, which are regularly held in Washington, New York, and Chicago, and it surpassed all earlier meetings of the Association in the number registered as in attendance. The registration figures for the last five meetings are as follows: Chicago (1921) 2413; Toronto (1921) 1832; Boston (1922) 2339; Cincinnati (1924) 2211; Washington (1925) 4206.

The fifteen sections of the Association were well represented, and 36 associated societies, of which 24 are affiliated, met with the sections of the Association. Eleven other scientific organisations met with the Association by invitation. Altogether 252 scientific sessions were held, as well as a large number of business sessions, dinners, etc. The total number of papers and addresses at Washington was about 1710.

Washington has more scientific workers in proportion to its population than any other city of the country. It has numerous institutions and organisations devoted to scientific research and to the spread of scientific knowledge. The George Washington University, the National Geographic Society, the many government scientific bureaux and offices, the Smithsonian Institution, the Carnegie Institution of Washington, the National Academy of Sciences, and the National Research Council are all of Washington, and all took active part in the arrangements for this meeting. The quarters of many of these organisations were made available for section and society sessions, and the Central High School building was secured for a large group of the sessions.

The exhibition for this meeting was exceptionally well developed, and offered many unusual opportunities for the actual inspection of apparatus, materials, and facilities for research and teaching, as well as newly developed scientific methods and recent publications. The general exhibition was the most complete and representative exhibition held by the Association in recent years. Fifty business firms that supply scientific instruments and materials, and publishers of scientific books, took part, and a large number of individual men of science exhibited new research methods and instruments. Special exhibitions by Washington scientific organisations formed an attractive feature this year. The annual exhibition of recent scientific work of the Carnegie Institution of Washington was specially maintained for this meeting. The new building of the National Academy of Sciences and the National Research Council, which is accounted the finest of its kind in the world, was open for inspection daily; a very attractive and inspiring permanent exhibition of scientific principles and methods was displayed in this new "Temple of American Science." Many of the offices and laboratories of the United States Department of Agriculture were open to visiting scientific workers. The U.S. Bureau of Standards, the New National Museum, the Old National Museum, the Smithsonian Institution building, and the Freer Art Gallery were also open for inspection. Exhibitions by scientific societies that took part in the meeting were arranged; these were generally of special interest to workers in the fields represented by the societies, and contained exhibits of research methods and apparatus shown by their originators.

With a rapidly increasing public interest in scientific knowledge, the recent annual meetings of the

American Association have received a progressively greater share of attention on the part of the daily press. One of the chief aims of the Association is to further the appreciation of science and the work of scientific men, and it has rapidly improved its publicity service in recent years. This service now constitutes a very important feature of each annual meeting. It aims at furnishing to the newspapers throughout the country interesting and trustworthy items from the various scientific programmes. The Publicity Committee was very efficiently helped by the co-operation of Science Service, which furnishes science news to a series of subscribing newspapers. For the first time in the history of the American Association, radio was used as an integral part of the publicity service. The two large stations in Washington broadcasted talks given by well-known scientific men whose influence on the upbuilding of science is generally recognised. The territory covered by the two stations is very wide, responses from their programmes having been received from Hudson Bay, Seattle, San Francisco, Long Beach, Los Angeles, Honduras, San Salvador, Cuba, and Haiti. Through radio talks, a vast number of people were reached who are deeply interested in the acquisition of scientific knowledge but unfamiliar with the channels through which accurate information may be obtained. The great value of thus broadening the contacts of the annual meetings of the Association and of stimulating a wider interest in and appreciation for scientific work can scarcely be overestimated.

Eight general sessions of the Association were held at Washington. The opening session occurred on Monday evening, December 29, in the Memorial Continental Hall. This session was addressed by the Honourable Charles Evans Hughes, Secretary of State, who spoke on "Some Aspects of International Co-operation." At this session was delivered the address of the retiring president of the Association, Dr. Charles D. Walcott, secretary of the Smithsonian Institution. The subject of Dr. Walcott's address was "Science and Service." Following the opening session, there was a general reception given by the local Association members. The reception was held in the New National Museum.

The second general session was held on Tuesday afternoon, December 30. The speaker at this session was Mr. Austin H. Clark, of the Smithsonian Institution, member of the Navy Department's Advisory Committee on Oceanography. Mr. Clark's subject was "The Navy's Oceanographic Program."

The third general session was held on Tuesday evening, December 30. This session was devoted to the third annual Sigma Xi lecture, held under the joint auspices of the Association and the Society of Sigma Xi. The lecture this year was by Dr. Frederick Fuller Russell, general director of the International Health Board, whose subject was "War on Diseases, with Special Reference to Malaria and Yellow Fever."

The fourth general session occurred on Wednesday afternoon, December 31. At this general session Dr. Charles D. Walcott gave a beautifully illustrated lecture of general interest on "Geological Exploration in the Canadian Rockies."

The fifth general session was held on Wednesday evening, December 31. A fine series of motion pictures, taken on the western excursion that succeeded the recent Toronto meeting of the British Association, was shown at this session. Dr. Edwin E. Slosson, director of Science Service, who took part in the trip, spoke. These films were very kindly loaned for this showing by the Provincial Motion Picture Bureau

of Ontario, Canada. Many striking and beautiful Canadian views were seen, and a number of eminent British scientific workers appeared in the pictures.

The sixth general session was held on Thursday afternoon, January 1. Prof. A. E. Douglass, director of the Observatory of the University of Arizona, spoke on the "University of Arizona Eclipse Expedition of September 1923," and showed beautifully coloured lantern slides. Besides its contribution of astronomical knowledge presented in an easily understood style, this lecture also presented something of desert adventure that did not fail to attract attention.

The seventh general session occurred on Thursday evening, January 1. Dr. Willis T. Lee, of the United States Geological Survey, gave a lecture at this session, on "Explorations in the Carlsbad Caverns of New Mexico." The studies reported were carried out under the auspices of the National Geographic Society. Dr. Lee's illustrations included motion pictures secured by means of flares in these very interesting caves.

The eighth general session was held on Friday afternoon, January 2. Motion picture films illustrating the principles and operation of the telephone, human speech, etc., were given their first public showing, and an explanatory talk was given by Dr. John Mills, of the Western Electric Company of New York City.

The following is a list of the vice-presidential (sectional) addresses delivered at Washington; they are being published in full in *Science*:—Section A (*Mathematics*)—"The Foundations of the Theory of Algebraic Numbers." By Harris Hancock, University of Cincinnati. Section B (*Physics*)—"Trend of Thought in Physics." By W. F. G. Swann, Yale University. Section C (*Chemistry*)—"Some Effects of the Atmosphere upon Physical Measurements." By E. W. Washburn, National Research Council, Washington, D.C. Section D (*Astronomy*)—"The Equinox of 1950." By Heber D. Curtis, Allegheny Observatory, Pittsburg, Pa. Section E (*Geology and Geography*)—"A Classification of Natural Resources." By N. M. Fenneman, University of Cincinnati. Section F (*Zoological Sciences*)—"Darwin and Bryan: a Study in Method." By Edward L. Rice, Ohio Wesleyan University, Delaware, Ohio. Section G (*Botanical Sciences*)—"The Origin of the Cycads." By C. J. Chamberlain, University of Chicago. Section K (*Social and Economic Sciences*)—"The Development of Modern Family Life." By John Franklin Crowell. Section L (*Historical and Philological Sciences*)—"Leibnitz, The Master Builder of Mathematical Notations." By Florian Cajori, University of California. Section N (*Medical Sciences*)—"The Relation of Certain Free Living Micro-Organisms to Disease." By Richard P. Strong, Harvard University. Section O (*Agriculture*)—"Better Adapting our Educational and Investigational Efforts to the Agricultural Situation." By R. A. Pearson, Iowa State College. Section Q (*Education*)—"The New Social Order as seen from the Standpoint of Education." By Henry W. Holmes, Harvard University.

The Council of the Association met on various occasions during the meeting for the transaction of business, some items of which are of general interest.

Under the provisions of the Jane M. Smith Fund, the following three members were elected to emeritus life membership of the Association: Ira Remsen, Johns Hopkins University; E. S. Dana, 24 Hillhouse Ave., New Haven, Conn.; H. C. Yarrow, 814-17th St., N.W., Washington, D.C.

The sum of 3000 dollars was appropriated for grants for research in 1925, to be allotted by the Committee on Grants and disbursed from the available funds of

the treasurer's office. The Council appropriated 500 dollars as a temporary aid to the Union of American Biological Societies in its project for *Biological Abstracts*. It was decided that the annual meeting of December 1927 shall be held in Nashville, Tennessee.

Prof. Michael Pupin, professor of physics in Columbia University, New York, was elected president of the Association. The following vice-presidents (chairmen of sections) and secretaries of sections were also elected:—Section A: W. A. Roeber, professor of mathematics, Washington University, St. Louis; R. C. Archibald, associate professor of mathematics, Brown University, Providence, R.I. Section B: H. M. Randall, professor of physics, University of Michigan; A. L. Hughes, Washington University, St. Louis, Mo. Section C: H. B. Cady, professor of chemistry, University of Kansas; Gerald Dietrichson, University of Illinois, Urbana, Illinois. Section D: A. E. Douglass, professor of astronomy, University of Arizona; Philip Fox, professor of astronomy, Northwestern University, Evanston, Ill. Section E: R. A. Daly, professor of geology, Harvard University; G. R. Mansfield, U.S. Geological Survey, Washington, D.C. Section F: H. S. Jennings, professor of zoology, Johns Hopkins University; G. T. Hargitt, professor of zoology, Syracuse University, Syracuse, N.Y. Section G: R. B. Wylie, professor of botany, Iowa State University; S. F. Trelease, professor of plant physiology, University of Louisville, Louisville, Ky. Section H: C. B. Davenport, director of the Station for Experimental Evolution, Carnegie Institution of Washington; R. J. Terry, professor of anatomy, Washington School of Medicine, St. Louis, Mo. Section I: C. E. Seashore, professor of psychology, Iowa State University; F. N. Freeman, professor of physiology, University of Chicago, Chicago, Ill. Section K: F. R. Fairchild, professor of political economy, University; F. L. Hoffman, Babson Institute, Babson Park, Mass. Section L: W. A. Oldfather, professor of classics, University of Illinois; F. E. Brason, Congressional Library, Smithsonian Division, Washington, D.C. Section M: F. G. Cottrell, director of the Fixed Nitrogen Laboratory, U.S. Department of Agriculture; N. H. Heck, U.S. Coast and Geodetic Survey, Department of Commerce, Washington, D.C. Section N: A. J. Carlson, professor of physiology, University of Chicago; A. J. Goldfarb, professor of biology, College of the City of New York, New York, N.Y. Section O: C. V. Piper, agronomist, U.S. Department of Agriculture; P. E. Brown, Iowa State College, Ames, Iowa. Section Q: O. W. Caldwell, director of the Lincoln School, Columbia University; A. S. Barr, University of Wisconsin, Madison, Wis.

Other officers are: *Permanent Secretary*: Burton E. Livingston, director of the Laboratory of Plant Physiology, Johns Hopkins University, Baltimore, Maryland. *General Secretary*: W. J. Humphreys, professor of meteorology, George Washington University and U.S. Weather Bureau, Washington, D.C. *Treasurer*: J. L. Wirt, Carnegie Institution of Washington, Washington, D.C. *Elected Members of Council*: Dr. L. O. Howard, Chief of the Bureau of Entomology, U.S. Department of Agriculture, Washington, D.C.; Dr. D. T. MacDougal, director of the Desert Laboratory, Carnegie Institution of Washington, Tucson, Arizona. *Elected Members of the Executive Committee*: B. M. Duggar (1925), Missouri Botanical Garden, St. Louis, Mo.; Edwin B. Wilson (1928), Massachusetts Institute of Technology, Cambridge, Mass.; Vernon L. Kellogg (1928), permanent secretary of the National Research Council, Washington, D.C.

## Innermost Asia: its Geography as a Factor in History.

ON Tuesday, March 24, at a meeting of the Royal Anthropological Institute, Sir Aurel Stein read a paper on "Innermost Asia: its Geography as a Factor in History." It dealt with the part which the elevated drainageless basins between Tibet in the south and the great Tian Shan range in the north have played for two thousand years as a natural corridor for the interchange of the civilisations of China, India, and the West. This vast region, stretching for close on 1600 miles from east to west, is for the most part occupied by deserts of drifting sands, wind-eroded steppe, and bare gravel. By denying to this region adequate atmospheric moisture and grazing grounds, Nature has protected it from becoming the scene of great nomadic migrations and of the upheavals entailed by them. Cultivation all through historical times has there been entirely dependent on irrigation, and hence restricted to a thin string of oases along the foot of the encircling mountains.

The safe trade route passing through these oases was first opened when the Chinese in the last quarter of the second century B.C. forced the Huns to the north of the Tian Shan, and then pioneered a track into the Tarim basin through the Lop Desert. China's policy of Central-Asian expansion at first aimed at securing an open road westwards for its exports, and particularly for its silk fabrics, the most valuable of its industrial products, of which it long retained a monopoly. The necessity of safeguarding this road forced the Chinese empire into gradually extending political and then military control right across the Pamirs and even beyond.

Sir Aurel Stein, on the second and third Central-Asian expeditions undertaken under the orders of the Indian Government, traced this ancient Chinese route along its whole length. By systematically exploring the ruins of the watch stations once guarding the ancient Chinese border wall west of Tun-huang, and of ancient settlements in the Tarim basin, abandoned from the third century A.D. onwards, to the desert, on ground now wholly waterless, he brought to light abundance of interesting relics of the traffic and trade once passing along this road. Among the most noteworthy of these relics are remains of beautiful Chinese figured silks of the first centuries before and after Christ, and also of fine tapestries of unmistakably Hellenistic style. Hundreds of documents on wood in Indian script and language of the third century A.D. attest how the same route in the reverse direction served for that spread of Buddhist doctrine to the Far East which forms the most important of India's many notable contributions to the spiritual development of civilised mankind. Fine paintings on silk and stucco sculptures in plenty show how Græco-Buddhist art from the north-western marches of India simultaneously penetrated into China and influenced its native art.

The opening of the earliest route through the Lop Desert comprising the salt-encrusted dry bed of a prehistoric sea affords striking evidence of that remarkable power of intelligent organisation which enabled the Chinese through successive periods to overcome formidable natural obstacles. The same capacity, far more than force of arms, helped them to regain control of those distant regions more than once during successive ages after it had been lost through internal decay of imperial authority.

Plentiful archaeological finds, as illustrated by Sir Aurel Stein's slides, showed how the cultural influences of India, China, and the Near East intermingled in the Tarim basin during close on a thousand years.

The remarkable preservation of these remains proves the extreme aridity of the climate prevailing here since ancient times. The same atmospheric dryness has made it possible in the Lop Desert for bodies of inhabitants of ancient Lou-lan to survive in a remarkable state of preservation since the first centuries of our era. They suggest that the people in the Tarim basin, whom we know spoke various Indo-European languages, showed in their physique the same *Homo alpinus* type which Mr. Joyce's analysis of the anthropometrical material collected by Sir Aurel Stein proves to be the prevailing element in the racial constitution of the present population of the oases.

## University and Educational Intelligence.

OXFORD.—A special course in zoology for teachers of science in secondary schools has been arranged for in the department of zoology and comparative anatomy from July 31 to August 11. Forms of application and all particulars can be obtained from the Rev. F. E. Hutchinson, Acland House, Broad Street, Oxford.

APPLICATIONS are invited by the trustees of the Manchester Royal Infirmary for the Dickinson Surgery Scholarship, value 75% for one year. The scholarship is open to students who have received at the university and the infirmary, instruction in pathology, medicine, and surgery necessary for the taking of the M.B., Ch.B. (Manchester) degree. The latest date for the receipt of applications (in each case six in number) by the Secretary is April 30.

AN Educational Policy for Tropical Africa is outlined in a memorandum prepared by the committee appointed in November 1923 to advise the Secretary of State for the Colonies on such matters, and published as command paper 2374 of March 1925. Mr. Ormsby-Gore, Parliamentary Under-Secretary of State for the Colonies, is the chairman of the committee, which includes also the Bishop of Liverpool, Sir Frederick Lugard, Sir Michael Sadler, Major A. G. Church, and Mr. J. H. Oldham. Native education, which, until recently, has been largely left to the Mission Societies, will, if the committee's views are adopted, become the field of a great government missionary enterprise, the keynote of which would be adaptation to native life. The point of view is conservative in the best sense. The salvaging of the best of barbarism is recognised as a necessary condition of the growth of anything worth calling civilisation. A dual system is to be maintained, and, in provided and non-provided schools alike, as well as in training colleges, religious teaching and moral instruction are to be accorded an equal standing with secular subjects. Examinations are not to be given the position of cardinal importance they have usurped so often, for the conditions under which grants-in-aid are given are not to be dependent on examination results. Supervision is to be exercised through an adequate staff of government inspectors, whose reports are to be based on frequent and unhurried visits, a primary purpose of which will be to make the educational aims understood and to give friendly advice and help in carrying them out. Departmentalism, which has so greatly vitiated the working of government educational administration in the past, is to be kept in check by close co-operation, as in the United States, with every department of government concerned with the welfare of the people or vocational teaching, including especially the departments of Health, Public Works, Railways, and Agriculture. To be instrumental in carrying out such a policy is an ambition that should fire the enthusiasm of university men not less than did the Indian Civil Service in its palmiest days.

## Early Science at Oxford.

April 20, 1686. Dr. Plot read an account of making brasse, as it is practised in Holland.

April 22, 1684. Dr. Smith communicated some abstracts of letters, he lately received from beyond Sea.

From Paris: Monsieur Auzout affirms, that no great Loadstone, tho capped, will take up above 12, or 15, times its weight, but, he says, that in Italy he has seen little Loadstones, which have rais'd 80 times their weight, and some 140 times their weight.

In a certain province of Nova Francia, there is so great a quantity of salt peter in ye feilds, that ye oxen there are so salt that they cannot eat their flesh, for 3 or 4 months in ye year, ye steams of salt peter falling in that abundance upon ye grass.

Sheep in Affrick, that have teeth with *aurea armatura*.

Bees in ye West Indies which have no sting; which place ye young ones in their honey; and their faeces in separte cells: their honey is as clear as water.

From Liège: On ye 4th of February S.N. severall Colliers were imprisoned in a Colepit at Herstol, half a league from Liège through a vein of water gushing in very violently upon them. Twenty four days were spent in drawing off ye water, and upon ye 25th, they were taken up all alive, not having had one morsell of bread during all that space; and subsisting onely upon a spring that flowed near them: a great quantity of this water was evaporated, to try, if they could discover any thing of nourishment in it, more than in common water, but they found nothing but a scarce perceptible calx remaining.

From Paris: A New Mathematicall Instrument lately invented at Paris, made very comodious for travelling, and so light, that it may be carried in one's pocket; it serves for a semicircle, sector, square, measuring all sorts of angles whatsoever, takeing ye weight of bullets, ye declination from ye North, ye inclination, or reclination, of any wall, or whatever it be, and many other uses it hath, which seem to be demonstrable.

Dr. Plott brought in an account of ye effects of ye late hard frost on ye vegetable kingdom, drawn up by Mr. Bobart, Gardiner to ye University. Capt. Ralph Snedy of Bradwell in Staffordshire, sais that a great oak at Chebsey in that County, vallued at 12d. ye last Autumn, was splitted quite thro by ye frost this Winter. Dr. Plot also informed ye Society, that both resinous and gummy, trees have suffered very much by ye last Frost; but ye latter much more than ye former: likewise he shewed ye Society a lamp, whose wick was made of Salamander's wool, in order to a Discourse of sepulchral lamps now under his hands. A letter was lately received from Mr. King of Ingestre, in Staffordshire, concerning an æquinoctiall Diall in that Country, representing a booke opened, ye edges of ye booke were Gnomons, casting a shade on ye opposite side, where ye hours were exprest by parallel lines.

April 23, 1686. Being St. George his Day, ye day of Election, Dr. Wallis was chosen President, Dr. Plott Director of Experiments, Mr. Caswell Treasurer, Mr. Bainbrig and Mr. Walker Secretaries.—Ordered that ye payments be sunk down to 2s. 6d. a quarter, for ye year ensuing.

1690. Ordered by the Society, that all members of the Society who have paid their arrears on Lady Day, 1688, are to receive six books of Aristarchus, printed at the charge of the Society.

Officers for the ensuing yeare: Dr. Bathurst President, Mr. Pit and Mr. Hans Secretaries, Dr. Musgrave, Director of Experiments, Mr. Pullen, Treasurer.

## Societies and Academies.

## LONDON.

Physical Society, March 13.—Jas P. Andrews: The variation of Young's modulus at high temperatures. The variation is found for zinc, silver, phosphor-bronze, lead, and soda glass by a static method, to within about 150° of the melting-point. It varies exponentially with temperature, so that  $q$  (Young's Modulus)  $= q_1 e^{-b_1 t}$  (where  $q_1$  and  $b_1$  are constants) up to a temperature roughly half-way from about zero to the melting-point, and  $q = q_2 e^{-b_2 t}$  for the remainder — E. G. Richardson: The critical velocity of flow past objects of aerofoil section. By observations of the "Æolian tones" of vibrators of aerofoil section, critical values for flow past an object of aerofoil section have been obtained of a fluid incident at various angles. The minimum value of  $VL/\nu$  for unsteady flow falls from 60 at 0 incidence to 45 at 20, and then more rapidly.—J. Brentano: A focussing method of crystal powder analysis by X-rays. For any given angle of reflection, a surface of double curvature can be found, such that it will reflect X-rays coming from one point, to any other definite point. For an element of this surface, situated so as to be distant from the two points by lengths  $a$  and  $b$  respectively, the relation  $\sin a/\sin \beta = a/b$  must be satisfied, where  $a$  and  $\beta$  are the glancing angles of incidence and of emergence of the X-rays with respect to the surface. An arrangement for crystal analysis based on this relation is discussed.

## DUBLIN.

Royal Irish Academy, March 16.—J. J. Nolan, R. K. Boylan, and G. P. de Lachy: The equilibrium of ionisation in the atmosphere. The large ions in the atmosphere carry single electronic charges. They constitute a constant fraction of the nuclei of the atmosphere, and the ratio of the uncharged nuclei to the large ions of one sign is approximately 1.28. The equilibrium between small ions ( $n$ ) and large ions ( $N$ ) is determined by the equation  $q = an^2 + 2\eta_2 Nn$ ,  $\eta_2$  being the recombination coefficient between small ions and large ions of the opposite sign. Where large ions are plentiful,  $q = 2\eta_2 Nn$ . The value of  $\eta_2$  is  $9.7 \times 10^{-6}$ . The large ions exert a marked effect on the atmospheric potential gradient.

## PARIS

Academy of Sciences, March 2.—G. Koenigs: The differential equations of movements with two doubly decomposable parameters.—Maurice Hamy: The photography of the stars in full daylight. A modified Lindemann method is described which permits of the determination of the magnitude of the stars photographed.—Roland Thaxter was elected corresponding member for the section of botany in succession to the late M. De Toni.—R. H. Gernay: A method of integrating by successive approximations of systems of partial differential equations of fixed form.—Mandelbrot: The analytical prolongation of monogen functions in the sense of Cauchy into isogen functions in the sense of Volterra.—René Lagrange: The quadratic integrals of the equations of mechanics.—St. Kempisty: Approximative (asymptotic) limits.—Harald Bohr: Nearly periodic functions with one complex variable — Salet: The independence of the velocity of light and of that of the source of light.—E. Delcambre, Ph. Wehrle, and L. Gouton: The variability of true astronomical refractions. A description of an experiment from which it is concluded that on a single angular measurement of isolated stars, the approximation to 0.01" is illusory,

even for small zenithal distances, and this is also the case for the approximation to  $0.1''$  for zenith distances higher than  $45^\circ$ .—E. Henriot and R. Moens: The action of light on the thermionic phenomenon. The light of an arc lamp, interrupted 1000 times per second by a toothed wheel, is focussed on an incandescent tungsten filament. Under these conditions, a telephone interposed in series with the high-tension battery in the filament-plate circuit gives the sound corresponding to the 1000 frequency. If the current through the filament is too small, the sound is not heard, and it is only apparent within a narrow range of current. The phenomenon appears to be purely thermal, and is not really photo-electric.—C. G. Bedreag: Physical system of the elements.—A. Boutaric and Mlle. F. Demora: The phenomena of diffraction presented by a network composed of alternative transparent and opaque sectors.—F. Holweck: Exact measurements of spectral frequencies in the domain of the radiations comprised between light and the X-rays (the L III discontinuities of Cl, S, P, Si, Al).—J. Salauze: The electrolysis of the alkaline acetates in solution in methyl alcohol. Comparing the effects in the two solvents, water and methyl alcohol, in the latter, oxidation phenomena are absent, and the yield of ethane is higher (95 per cent. against 85 per cent.). The nature of the anode has a much smaller influence on the course of the reaction in methyl alcohol than in aqueous solution.—Paul Pascal: The magneto-chemistry of polymers. Measurements of the magnetic susceptibility of the metaphosphates. Conclusions can be drawn from the data concerning the complexity of the various forms of metaphosphate.—A. Bigot: Clays, kaolins, light silicas; density, porosity, occluded gases.—B. Cabrera: The rare earths and the magneton question.—H. Wuyts: General method for the preparation of the ether oxides. To the alcohol 10 per cent. of sulphuric acid is added, and the mixture slowly distilled through an efficient fractionating column. The alkyl oxide, alcohol, and water distil as azeotropic mixtures, from which the alkyl oxide (ether) can be separated.—Louis Jacques Simon: The relations between sulphochromic oxidation and structure.—Lespieau and Charles Prévost: Diacetylene. By the action of excess of alcoholic potash on erythrene tetrabromide, a gas was obtained which liquefies at  $-35^\circ\text{C}$ . and boils at about  $10^\circ\text{C}$ . It was not analysed, but its physical properties and chemical reactions correspond with those of diacetylene  $\text{CH}_2\text{C}\equiv\text{C}\cdot\text{CH}_2$ .—R. Fric: The presence of methane in various outflows of gas observed in the Limogne d'Auvergne. The gas from a trial boring was collected and analysed, and found to contain carbon dioxide, sulphuretted hydrogen, oxygen, nitrogen, and methane (19.8 per cent.).—Alphonse Berget: A marine refractometer with double deviation. This instrument consists of two hollow prisms, one inside the other. The outer one is filled with a liquid of known refractive index, the liquid of which the refractive index is required being placed in the inner prism. Both liquids are necessarily at the same temperature, and the accuracy of the differential measurement is one in the fifth place of decimals.—A. Gruvel: Remarks on the salinity curve of the waters on the western coast of Morocco.—P. Bugnon: Leaf homologues in the sweet violet: vegetative leaves, pre-leaves and bracts.—Henri Coupin: The peroxidases in dry seeds. The benzidine-hydrogen peroxide reagent serves well to detect peroxidases in dry seeds.—Mlle. G. Bonne: The presence of internal phloem in some Rosaceae.—Lisbonne: The activation of the pancreatic juice by acidification.—Jean Saidman: The photo-electric effect produced

by ultra-violet light in man. Normally a man exposed to ordinary daylight loses negative electricity, and the rate of loss is unchanged by exposure to a 2000-candle half watt lamp. But submitted to ultra-violet light (quartz mercury lamp), a rapid discharge is produced.—A. Dognon: The biological action of monochromatic X-rays of different wavelengths on the egg of *Ascaris*.—Pierre P. Grasse: Cysts of *Prowazekella* and *Blastocystis*.—A. Henry and Ch. Leblois: Attempt at the classification of the *Isospora*.—H. Penau and H. Simonnet: Prolonged insulin treatment and survival of the dog without pancreas.

#### WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 11, No. 1, January 1925).—W. Lindgren: (1) The cordierite-anthophyllite mineralisation at Blue Hill, Maine, and its relation to similar occurrences. The Ellsworth schists here contain mainly quartz, biotite, and chlorite, and the ores form lenticular replacements in them. The type of mineralisation described is recorded for the first time in America, and appears to be due to emanations from the granite outcrop nearby. The deposit is similar to those of Fennoscandia. (2) Gel replacement, a new aspect of metasomatism. Gel replacement in solid rocks operates in general at medium to low temperatures, probably not above  $300^\circ\text{C}$ . Solutions or sols attack the matrix and the space is filled by a gel of high concentration. If crystallisation takes place slowly, concentric fibrous texture results; if it is almost simultaneous with deposition, there may be apparent continuity. The theory is applied to replacements by silica gel, sulphides, and to the veins of Cobalt, Ontario.—J. W. Gowen, H. W. Leavitt, and W. S. Evans: Mortar strength, a problem of practical statistics. The correlation coefficients for tests after 7-day and 28-day curing respectively are high, so the behaviour of mortar can be safely predicted on the data from 7-day tests.—Raymond Pearl and L. J. Reed: Skew-growth curves.—J. H. Mueller: Chemical studies on tuberculin. The active principle of tuberculin may be a protein or a protein degradation product; on the other hand, the specific precipitable material of tuberculin is resistant to the action of proteolytic enzymes.—S. K. Allison and W. Duane: On scattered radiation due to X-rays from molybdenum and tungsten targets. X-ray tubes of small diameter and a multiple slit system were used. With a narrow beam of primary rays the ionisation curves show a narrow peak beside the unshifted peak, and with a wide beam, a broad shelf, both of which were in agreement in position, for several radiators, with Compton's theory.—C. M. Blackburn: An application of the quantum theory of band spectra to the first negative Deslandres group of carbon. The bands lie in the ultra-violet between 2100 and  $2900\text{ \AA.U.}$  The emitter seems to be a dipole molecule in simple rotation about a non-precessing axis perpendicular to the line joining the nuclei.—W. W. Coblenz and C. O. Lampland: New measurements of planetary radiation and planetary temperatures. By means of a series of transmission screens, the radiations were separated into spectral groups and the radiation intensity of each determined by new radiometers. The unilluminated part of the disc of Venus emits much infra-red radiation, suggesting a short rotation period (1-10 days). Illuminated regions of Mars seem to be at  $5-15^\circ\text{C}$ .; polar regions, perhaps  $-70^\circ\text{C}$ .; dark phase on sunrise side, perhaps  $-60^\circ\text{C}$ . Surface temperature of Jupiter and Saturn appears to be  $-60^\circ$  or  $-80^\circ\text{C}$ .—E. H. Hall: The number of free

electrons with a metal. The relation between the atoms, free electrons, and ions within a metal are essentially those of dissociation equilibrium. The free electrons may be 2-3 per cent. of the number of atoms and increase with temperature. This gives an ionising potential of the solid metal of  $\frac{1}{3}$  volt for cobalt to  $\frac{1}{3}$  volt for iron at  $0^\circ\text{C}$ .—F. G. Keyes and F. W. Sears: Recent measurements of the Joule effect for  $\text{CO}_2$ . A glass bomb containing the gas is broken in a vacuum and the temperature change measured by a platinum resistance wire.—H. B. Lemon: The comet tail spectrum and Deslandres' first negative group. Helium pumped through activated carbon gives a brilliant comet tail spectrum. The spectrum is also given by a hydrogen tube containing carbon cooled to liquid air temperature and with a hot cathode, but is feeble.—W. F. Meggers: The periodic structural regularities in spectra as related to the periodic law of the chemical elements. The spark spectrum (from ionised atoms) resembles in structure the arc spectrum (from neutral atoms) of the preceding element (Displacement Law). Even and odd structures, *i.e.* doublets and triplets, etc., characterise the arc spectra of alternate elements in columns I-VIII. of the periodic classification, and even and odd structures their spark spectra (extension of Rydberg's Alternation Law). Experimental verification.—E. L. Nichols: Notes on neodymium oxide. The oxide in bulk or in a bead gives a band spectrum of two identical sets, though the bands are generally in different places. There are two absorption spectra: the reversal of the band spectrum and the spectrum of an aqueous solution. The same two sets of bands appear together with a third.—A. H. Pfund: Halogen isotopes and infra-red reflection spectra. Potassium salts of the halogens have as many bands of selective reflection in the infra-red as there are isotopes. Plotting wave-numbers ( $1/\lambda$ ) against atomic weights gives two parallel straight lines, the lighter isotopes, together with iodine, falling on one line.—P. A. Ross and D. L. Webster: (1) The Compton effect with no box around the tube. The apparatus was so arranged that radiation from any light element other than the secondary radiator had to travel a distance by which, according to the inverse square law, its intensity would be made negligible. Compton's predicted shift is confirmed, but no trace is found of the tertiary radiation suggested by Duane. (2) Compton effect: evidence on its relation to Duane's box effect. The intensity of scattered radiation from a box enclosing the X-ray tube and secondary radiator as calculated using Barkla's mass-scattering coefficient is inadequate to explain the peak observed by Duane in the box experiments.—H. Boschma: The nature of the association between Anthozoa and Zooxanthellæ. Coral polyps containing algæ are substantially parasitic on them, apparently owing to lack of organic food. Given organic food, they cease to ingest the algæ.—T. L. Davis: The mechanism of reactions in the urea series. The mechanism in many cases is the reversible combination of molecules: the urea derivatives de-arrange or break down in a predictable manner analogous to the de-arrangement of urea into ammonia and cyanic acid.—L. J. Gillespie: An equation for the Haber equilibrium.—G. Glocker: A critical potential of methane and its absorption in the ultra-violet. The maximum in the current-potential curve of three- and four-electrode methane tubes is not due to a resonance potential.—H. W. Underwood, Jr.: Studies in catalysis. Negative catalysts or "stabilisers" seem to act by the formation of loosely combined molecular compounds.—W. J. Crozier and H. Federighi: On the measurement of critical thermal increment for biological processes. The logarithm of

frequency of heat-beat in the silk-worm bears a linear relation to the reciprocal of the absolute temperature; elaborate precautions are necessary to eliminate chance variations.—P. Bailey and Harvey Cushing: Microchemical colour reactions as an aid to the identification and classification of brain tumours.—S. Flexner: Virus encephalitis in the rabbit. The contents of febrile herpes vesicles and allied substances from man set up this inflammation of the brain in the rabbit. The virus appears to have at times a general distribution throughout the human body.—W. J. Luyten: Notes on stellar statistics: II. The mathematical expression of the law of tangential velocities.—G. C. Evans: Economics and the calculus of variations.—E. Kasner: Separable quadratic differential forms and Einstein solutions.—D. N. Lehmer: On a new method of factorisation. Legendre's method of factorisation, which makes use of the fact that all numbers having a given quadratic residue contain only such prime divisors as belong to certain linear forms, is to be utilised to construct stencils. The combination of any number of sets of these forms can then be accomplished by piling the corresponding stencils one on top of the other.—A. D. Michal: Functionals of curves admitting one-parameter groups of infinitesimal point transformations.—E. C. Jeffrey: (1) Resin canals in the evolution of the conifers. Contrary to current opinion in Europe, it is concluded, from the evidence of wound resin canals in fossil coniferous woods, that the Abietinæ (pines) represent the parent stock of the group (2) The origin of parenchyma in geological time. Storage parenchyma has been derived from tracheids; it appeared first at the end of the annual ring, being related to the extra supplies required by the cambium in spring, and often shows every gradation towards tracheary elements

### Official Publications Received.

- University of Illinois Engineering Experiment Station. Bulletin No. 145: Non-Carrier Radio Telephone Transmission. By Hugh A. Brown and Charles A. Keener. Pp. 26. (Urbana, Ill.) 15 cents.
- Shirley Institute Memoirs. Vol. 8, 1924. Pp. vi+362+iv. (Manchester: British Cotton Industry Research Association, Didsbury.)
- State of Illinois Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 15, Art. 4: A Preliminary Report on the Occurrence and Distribution of the Common Bacterial and Fungous Diseases of Crop Plants in Illinois. By L. R. Tehon. Pp. viii+175-325. (Urbana, Ill.)
- Records of the Botanical Survey of India. Vol. 10, No. 2: The Botany of the Abor Expedition. By I. H. Burkill. Pp. 115-420+10 plates. (Calcutta: Government of India Central Publication Branch.) 5.3 rupees; 8s 6d.
- Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 5, 1923. V: Hydrografiska matningar i Sverige. Pp. 36+4 plates. (Stockholm.) 5 kr.
- Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 3, No. 1: Meteorologiska Resultat av en Sommarsegeltur runt de Brittiska Öarna (Meteorological Results of a Summer-Cruise round the British Isles) With an English Summary. Av Carl-Gustaf Rossby. Pp. 16. (Stockholm.) 1 kr.
- Abisko Naturvetenskapliga Station. Observations météorologiques à Abisko en 1917. (Meteorologiska Iakttagelser i Abisko år 1917) Reunges par Bruno Rolf. Pp. 75. (Stockholm.)
- Board of Education. Vacation Courses in England and Wales, 1925. Pp. 18. (London: H.M. Stationery Office.) 6d. net.
- The Quarterly Journal of the Geological Society. Vol. 81, Part 1, No. 321, March 25th. Pp. xlviii+112+9 plates. (London: Longmans, Green and Co.) 7s. 6d.
- Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. Vol. 9, 1924. Pp. 700. (London: The Society of Chemical Industry.) 7s. 6d.; to non-members, 12s. 6d.

### Diary of Societies.

SATURDAY, APRIL 18.

- MINING INSTITUTE OF SCOTLAND (Annual Meeting) (at Royal Technical College, Glasgow), at 3.—Prof. H. Brigg: Sinclair's Treatise on Coal-mining, 1672 (Seventeenth Century Mining in East Lothian).—J. H. Cockburn: The Principles and Operation of the Mines (Working Facilities and Support) Act, 1923, Part 1.—C. N. Kemp and W. M'Laren: Demonstration on Coal Washing.
- INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at Municipal College of Technology, Manchester), at 7.—A. Hill: Foundry Materials.





SATURDAY, APRIL 25, 1925.

## CONTENTS.

	PAGE
Health in the Tropics . . . . .	593
Tropical Timbers. By A. L. Howard . . . . .	595
Foundations of the Theory of Optical Instruments. By Dr. L. C. Martin . . . . .	597
Medieval Science. By E. J. Holmyard . . . . .	599
Our Bookshelf . . . . .	600
Letters to the Editor :	
Permo-Carboniferous Glaciation and the Wegener Hypothesis.—Prof. A. P. Coleman, F.R.S.; Prof. J. W. Gregory, F.R.S. . . . .	602
International Co-operation in Phenological Research. —J. Edmund Clark . . . . .	602
Depth-recording with Plankton-nets.—F. S. Russell . . . . .	603
Spectroscopic Evidence of <i>J</i> -Transformation of X-rays.—Dr. S. R. Khastgir and W. H. Watson Acidity produced in Salt Solutions by Sphagnum.— Dr. Macgregor Skene and Gladys L. Stuart Three Cases of Abnormal Anterior Abdominal Veins in the Frog.—Dr. Nellie B. Eales . . . . .	604
The Life-History of Amœba.—Dr. Monica Taylor Total Intensity of Scattered X-radiation.—O. K. DeFoe and W. W. Nipper . . . . .	605
The Auroral Green Line.—Prof. J. C. McLennan, F.R.S. . . . .	606
The Mortality of Plaice.—Dr. William Wallace . Robert Browning as an Exponent of Research.— Prof. W. R. Whitney . . . . .	607
Physiology and "Vital Force." By Prof. Fraser Harris . . . . .	608
The German Museum of Science and Technology Obituary :— Dr. Carl Ulrich By Dr. Robert W. Lawson . . . . .	611
Current Topics and Events . . . . .	612
Our Astronomical Column . . . . .	613
Research Items . . . . .	616
The International Geographical Congress . . . . .	617
The Preservation of Food . . . . .	620
Navigation and Fishing on the Ganges. By Dr. Henry Balfour, F.R.S. . . . .	621
Synthetic Methyl Alcohol . . . . .	622
University and Educational Intelligence . . . . .	622
Early Science at Oxford . . . . .	623
Societies and Academies . . . . .	624
Official Publications Received . . . . .	624
Diary of Societies . . . . .	628
Recent Scientific and Technical Books . . . . .	628
	Supp. v

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## Health in the Tropics.

THE medical conference which was held in the West Indies during last summer was probably unique in the history of medical science in that it was organised by a purely commercial company. The delegates, amongst whom were many distinguished men, were the guests of the United Fruit Company, and it is a remarkable fact that a wealthy commercial undertaking, having its offices in New York, should have a Medical Department, and that its directors should accept the advice of the general manager of that Department to issue invitations to laboratory workers and clinicians belonging to many nations to attend, as the guests of the Company, a conference to be held in a colony of the British Empire situate in the West Indies.

The particular conference was specially charged with showing to the guests what the Company is doing to maintain the health of its employees in tropical America and with obtaining, by discussion, suggestions for still further improvement of the conditions of life. The lesson is of supreme scientific importance, and is one which should be learned by all those, whether of British or any other nationality, who are engaged in commercial enterprise in tropical lands. The United Fruit Company has realised that sanitation pays and has acted accordingly. It has had the will to do the things that are necessary and has recognised the fact that what cannot be afforded is to leave them undone.

Scientific investigation has revealed the method of spread of practically all the diseases which are liable to afflict the dweller in the tropics, and the means of controlling these diseases are well known. Yet such is the scepticism or lethargy of those in command that in many cases they refuse to recognise the fact that sanitation is a commercial proposition repaying all the trouble taken in hard cash, which is the ultimate aim of all business undertakings. It is to be hoped that the demonstration given by the United Fruit Company will be thoroughly appreciated and, what is more important, acted upon.

One of the principal topics of discussion at the conference was the possibility of the white man becoming an inhabitant of the tropics. It is often assumed that the wonderful advances in tropical medicine will make the tropics a suitable home for the white man, and that in days to come the tropics will displace the temperate zones as the centres of activities of the world. This appears to be the view of the majority of those present at the conference. They believe that the attainment of normal longevity is not difficult provided that industrious habits are maintained, restraint as regards indulgence in intoxicating liquors is practised, and venereal disease and parasitic infections—especially hookworm and malaria—are avoided. Sir

James Fowler<sup>1</sup> is convinced that even if these risks are met, over and above them all there is something which cannot be avoided. The crux of the whole problem appears to him to be the children, and he claims that if the Englishman is to become as much at home in the tropics as he is in England, he must be able to rear his family there. If he cannot do this he will certainly remain, as he now is, only a migrant.

Whichever of these two opposed views is correct, it still remains a fact that, by attending to sanitation and preventive medicine, a great deal can be done to diminish the sick rate amongst white men in the tropics. Sir James Fowler points out that as regards the general sanitation of Jamaica, the municipal authorities stand condemned on every count, and should be replaced by an administration armed with powers adequate to the cleansing of such an Augean stable. In contrast, the farms of the United Fruit Company are described as sanitary oases in an unsanitary desert. The Company owns the only possible hotels in Jamaica. When it takes over an estate, its first procedure is to build a hospital, to erect mosquito-proof workmen's dwellings and farm buildings, to instal all necessary sanitary appliances and to establish a satisfactory water supply, so that everything required to protect the health of employees is ready on their arrival.

The report of the Medical Department of the Company for 1923 consists of 180 pages, and shows that there is a staff of 50 doctors, 43 registered nurses, and 442 workmen. Nearly every well-known university and medical college in the United States is represented among the personnel. In addition to the establishment of a highly equipped medical organisation, the Company has built churches and schools, has erected club-houses and amusement halls, and has provided athletic grounds, all of which contribute very largely to the creation of an atmosphere of content, without which the mental depression noted above creeps in and so lowers vitality that inevitable sickness results.

One of the diseases which requires constant vigilance in tropical America is yellow fever. Thanks to the investigations of the American Commission in 1900, it is known that the disease is carried by the black and white mosquito *Stegomyia fasciata*. Noguchi has isolated from cases of the disease a spirochæte which he has named *Leptospira icteroides*. It has been recovered from cases in several distinct outbreaks of the disease, but, though Noguchi claims that in animals the organism reproduces the disease, there are some who doubt whether it is really the actual cause of yellow fever. Agramonte, one of the original members of the 1900 Commission, was present at the conference.

He claimed that the only conclusive proof would be the reproduction of yellow fever in human beings by inoculation of a pure culture of the organism. He threw down the challenge to Noguchi and offered to produce the necessary volunteers. If the organism should prove not to be the cause of yellow fever, then there would be little argument for employing the serum and vaccine which are produced from it in the treatment of the disease.

The subject of yellow fever leads to Panama, for, as is well known, it was only as a result of the control of mosquitoes, the carriers of malaria and yellow fever, as organised by General Gorgas, that the construction of the canal became a possibility. Here again is the same object-lesson—strict attention to the protection of employees from tropical diseases alone rendered possible this great achievement. The work accomplished, the question arose as to whether there was justification for the enormous expenditure of money which the maintenance of the sanitary condition involved. In June 1921 there arrived on the Isthmus a special Panama Canal Commission appointed by the Secretary of War. It consisted of a Brigadier-General of the Army, a Captain of the Navy, and two business men. They recommended that the amounts expended for sanitation in the Canal Zone be greatly reduced, and if, as a result, the sick and death rate from malaria rises above the average in twenty of the largest cities of the United States, the sanitary precautions be increased. This recommendation was not accepted by the Secretary of War, but nevertheless attempts were made to reduce expenditure. The reductions chiefly concerned Silver City, and the result was that in 1922 there was more than five and one-half times the usual incidence of malaria.

Another danger arises from the settlers, those discharged labourers who have been given a portion of land to cultivate. The result of this policy, again, has been a large increase in the number of cases of malaria among non-employees who are widely scattered over the available parts of the Zone. It is estimated that 650 families are now living on the land in this way. This population is difficult to control, and is liable to form a reservoir of malarial infection which will become a danger to those whose work requires them to be exposed at night in unsanitated areas. On the other hand, it is claimed that these settlers bring advantages in the increase and cheapening of food. It is evident that in such an area as the Panama Canal Zone and in the thousands of similar areas in all parts of the tropical world, the health of employees can only be maintained by the strictest vigilance, and the necessary expenditure has been shown by the United Fruit Company to be an investment which will bear the closest scrutiny.

<sup>1</sup> "An Impression of Jamaica and the Panama Canal Zone" By Sir James K. Fowler. Pp. 60. (London: Eyre and Spottiswoode, Ltd., 1924) 2s.

### Tropical Timbers.

*Timbers of Tropical America.* By Prof. Samuel J. Record and Clayton D. Mell. (Published on the Foundation established in memory of Amasa Stone Mather of the Class of 1907, Yale College.) Pp. xviii+610+50 plates. (New York: Yale University Press; London: Oxford University Press, 1924.) 10 dollars.

NEARLY the whole of this work is made up of descriptions of the trees and woods of tropical America by Prof. Record, professor of forest products, Yale University, and the remainder, on tropical American countries and their forests, is by Mr. Mell, tropical forester. There are fifty pictures of forests, forest lands, individual trees, timber, and timber sections, and a very full description of seventy-five different families of trees, with full particulars of an innumerable number of different timbers. The whole forms a complete and up-to-date standard work, and is a very welcome addition to the somewhat bare library of books on the subject of the forests and timbers of the world.

Hitherto very little has been written either in regard to these forests or their timbers. This especially applies to the timbers of Brazil, about which there has been the utmost confusion, and in regard to Guiana the same can be said, excepting for Stone and Freeman's "Timbers of British Guiana."

The introduction of Mr. Mell's work is particularly valuable, because he has been over a large part of this vast country and gained his information first-hand; while the author has made a very thorough and patient study of the woods under the most favourable conditions. These vast tracts of forest and the magnificent timbers which they contain, and the rapidity of the growth, give the reader some consolation when he reflects upon the enormous demand which the world at present exacts for supplies from more accessible sources; so that while half of the world is deploring the want of transport facilities to enable them to destroy forests, the other half can rejoice that such difficulties are wellnigh insuperable.

Bernard Palissy wrote in the sixteenth century:

"I am quite astonished at the ignorance of man, for it appears that to-day he only studies how best to destroy the beautiful forests that his predecessors guarded so sacredly . . . for after all the trees have been cut down it will be necessary for all the arts to cease. . . . I have often wished to make a list of the arts which would cease if there were no longer any wood, but when I had written down a large number of them, I found that there would be no end to the enumeration, and, after due consideration, I came to the conclusion that there was not even one trade which could be carried on without wood."

The "ignorance of man" has caused him also to fail to make sufficient, or almost any kind of, provision for the future. Paul Charpentier in "Timber" wrote:

"To-day the hand of man has used, in such a manner and for so long, the treasures of Nature without foresight that the greatest preoccupation of cultivators of forests—the question which ought to attract the attention of Governments most—is the replanting with trees of the land once occupied by forest."

There is no sufficient practice, if any, of re-afforestation taking place in America. In Africa hundreds of thousands of giant trees have been cut down, and it is doubtful whether any scheme of re-afforestation in these dense tropical forests could be practised even if it was attempted; and in India and Burma, where scientific forestry has been practised for fifty-six years, no proper consideration has been given as to the planting of the most valuable sorts. The planting of mahogany has, for example, scarcely been seriously considered; yet in the Botanical Gardens of Calcutta there were three trees (*Swietenia mahoganii*), one of which was felled for improvements in the gardens, and proved to be of the most beautiful quality, equal to the best in Honduras; two others which were felled especially to be shown at the British Empire Exhibition, one of which had apparently required only 113 years to produce a diameter at the butt of 6 ft. 6 in., weighing 10½ tons, and containing 4007 ft. of board measure; and the other in 89 years having produced 4 ft. diameter at the butt, 4½ tons in weight, and 1575 ft. of board measure. The quality of the wood in these two trees was excellent.

Strange indeed it is that forest officers, only excepting in regard to teak in Burma and oak in Germany and Slavonia, have paid so little attention to the matter of providing for the future those trees which have been found to be so valuable in the past. The great French Minister Colbert said: "France will perish for want of wood." We should take his warning to heart, for, turning to Great Britain, in the past our reserves of forests have stood us in good stead, but our ash has gone, our oak is going, and the plentiful supplies of all kinds which have come to our rescue in times of national stress on more than one occasion will not be found in the future, unless we recognise the necessity of providing for our possible needs.

It is true that the Government has organised a Forest Department which is doing good work; and so far as it goes, this is something to the good, but it is quite an inadequate measure. Even if this Department had far greater resources and power, government departments are always cumbrous and of necessity work slowly on somewhat extravagant lines.

In the Slavonian country, whether the forests belong to government, to municipalities, or to private persons,

all alike have to conform to a regular rule; that is, for every tree that is allowed to be cut, a certain number have either to be planted, or if natural regeneration is taking place, protected and preserved; so that every year the area of forest land is not only maintained but also actually increased.

We have yet to find out the disaster which we have suffered, and are still suffering, by the loss of our wealthy landed gentry; it will be felt in the future in agriculture, but in timber the loss will be far greater. When at last all the great estates have been parcelled out, all the timber that can be sold will be cut to meet the levies of high taxation, and the real source from which our forest reserves have been accumulated will disappear. One of these great landowners not long since showed a vista of land from his house stretching for miles which in his grandfather's time was covered with trees of considerable value, but now the trees have altogether gone.

Paul Charpentier said that the cultivation of forests was a question which ought to attract the attention of governments most; if government were to institute a well-devised scheme by which every owner of land, instead of being taxed because of plantations, was given a remission of taxation on that account, much would be accomplished. The owner of land, whoever he may be, has a natural love for and desire to plant, but he is stopped from doing it because he knows he would be pounced upon by the revenue authorities. An excellent system is practised in Burma, under which the government lets out sections of land to growers of rice or "paddy"; these parcels of land are let on an entirely nominal rental, and the tenant has to plant his trees under the direction of the forest officer. After planting, the trees have to be tended and kept in good order, and at the end of a few years the ground is given up to the government and becomes forest, while the tenant moves on to another section.

The ignorance referred to by Bernard Palissy is largely due to the indifference shown in our educational work to the necessity for including forest subjects and a knowledge of trees as a study of first importance. It would be interesting to find what proportion of our population could identify even our own common trees. A greater knowledge would not only become of great national value, but would also raise the standard of the people's sense of the beauty of Nature.

This also suggests another phase, which is the extravagance of the British public in their use of timber. Free imports and a fairly high rate of money exchange have made it possible for us to be extravagant in this respect, so that timber which is highly valued in France, Germany, etc., and used with great regard to economy for all kinds of purposes, is here considered

unsuitable, and is used either for estate purposes or burned.

An Englishman visiting the timber yards on the Continent to-day is amazed to see the kind of material which is being used for decorative woodwork. In Great Britain, thousands of tons of highly selected timber of foreign origin are used in works where a much inferior quality would equally well serve the purpose; and so, while we fail to realise the importance of storing up a future supply for ourselves by wisely devised schemes of re-forestation, we are also spend-thrifts in regard to those supplies which we get from overseas. It is consoling at any rate that in the country about which Prof. Record gives us so much information there is a large reserve.

The book is arranged in order of families, with a summary following each kind, giving information for identification and comparison. The method is a good one for the student, but not altogether attractive to any who are not enthusiasts. It is a matter of regret that the admirable plan of showing forest areas by means of maps, adopted by Zon and Sparhawk in "Forest Resources of the World," has not been used here.

A bold pronouncement is made as to the source of real mahogany, when the author says: "Swietenia with five known species is the only source of true mahogany" (p. 348). He apparently overlooks Mr. Herbert Stone's remark in "Timbers of Commerce," p. 32, where a different conclusion is reached, and one which the reviewer endorses.

The question of nomenclature of timbers must always remain an exceedingly difficult and complex one. A certain latitude must be observed, and the use of the name "mahogany" is a case where a broad view should be taken. There are other woods where the case is quite different. It would be absurd not to call African mahogany "mahogany," yet according to the author's pronouncement it is not mahogany at all. The same would not apply to a wood like teak, because there is only one teak—*Tectona grandis*—and no other kind of timber from any part of the world possesses its qualities or its real appearance, so that to add the name "teak" to any other wood is wellnigh fraudulent.

The name "mahogany" has, however, throughout many years become a general term, and it is very doubtful if what was first known as mahogany was *only* the produce of *Swietenia*. The great similarity of so many other species is so remarkable that they can justly claim the right to the name.

The author attributes the slowness of the development of the general use of mahogany to the fact that the material was considered too difficult to work, but it seems more likely that the real cause was the pre-

judice which is invariably experienced in the introduction of any new timber, as well as the tax originally imposed.

Mahogany was first used by Cortez in 1521, by Sir Walter Raleigh in 1597, by Capt. Dampier in 1681, and first used in England for cabinet-making in 1754; yet we find that the greatest possible efforts were still being made in 1846 to persuade people to make more general use of this magnificent wood.

In a work which covers such a vast field it is not surprising that some debatable points should arise; for example, the author quotes a writer who states that East Indian satin wood is frequently confused with *Prima Vera* mahogany (p. 318), but even the amateur should not make this mistake, as there is a marked difference in texture and figure. It is stated also that East Indian satin wood is paler in colour than that of Porto Rico and Santo Domingo, but while the variation in colour generally is similar, much darker wood can be found from East India than from West India. Again, it is probable that the scents produced when working West Indian, East Indian, and Concha satin wood are all alike; certainly the scent of all three when burning is similar, although perhaps this is not so pronounced in the case of the last two named, which provides a rather interesting subject for the botanist. It is doubtful also whether the author would be able to sustain the description of Concha satin wood (p. 318) as being an inferior grade of wood. The gum streaks which it contains have militated against its popularity in America, but in all other markets it is most favourably received, and in individual cases has actually been preferred, generally, size for size, and value for value, and has realised fully as much as the regular satin wood.

There has always been the utmost confusion in regard to Brazilian woods, largely on account of the repetition of names, and because similar names have been applied to entirely different species. For example, sixteen kinds of *Canella* are mentioned on p. 179, including *Canella batalha*, *limao*, and *preta*. These all belong to the *Nectandra* sp., but there is an entirely different species also called *Canella*, that is, the Wild Cinnamon, the source of which is *Canella winterana*. There is no doubt that timbers of both species have been shipped on account of the name, regardless of which was required, to the utmost dissatisfaction of those who received them.

Prof. Record's specimen of *Pithecolobium vinhatico* is reported to weigh 37 lb. (p. 211). A brother of the well-known Mr. J. S. Gamble, who was many years in Brazil and got together a very exhaustive collection of Brazilian timbers, together with a host of information, produced a specimen of Amarello which he names as from

the same source, but which weighs 49 lb. The reviewer identifies this wood as being the equivalent to the *Adenanthera Pavonina* of the Andaman Islands. Mr. Gamble also had a specimen which the reviewer named Vinhatico, but which Gamble names as *Symplocos* sp. Again, Gamble's specimen of *Angelim amargosa* weighs 49 lb., and is attributed to *Anthelimum*. There is a specimen in Gamble's collection of *Arariba Rosa* to which the same source is given, weighing 40 lb. against Prof. Record's 55 lb. There is a specimen of *Arceira do Sertao*, which was traced as being *Astronium urundueva*, and possibly *Myrocrodon*, weighing 69 lb.

Those who have never attempted the task would be astonished at the immense amount of time and work which is required to unravel the maze surrounding the identification of timbers and to trace them to their original source. This book is full of new information, so that the authors are to be congratulated upon the painstaking efforts they have made in bringing all this material together. Every one interested in the subject of forestry and timber will be anxious to possess it.

A. L. HOWARD.

### Foundations of the Theory of Optical Instruments.

*Grundzüge der Theorie der optischen Instrumente nach Abbe.* Von Siegfried Czapski und Otto Eppenstein. Dritte Auflage. Bearbeitet von den wissenschaftlichen Mitarbeitern der Zeissischen Werkstätte: H. Boegehold, O. Eppenstein, H. Erfle, A. König, M. v. Rohr. Herausgegeben von H. Erfle und H. Boegehold. Pp. xx + 747. (Leipzig: J. A. Barth, 1924.) 30 gold marks.

A THIRD and greatly enlarged edition of this work, the original material of which was written by Dr. Siegfried Czapski for Winklemann's "Handbuch der Physik," has now been completed by several of the principal scientific workers in the firm of Zeiss. The death of Ernst Abbe in 1905, followed by that of Czapski two years later, removed the original mastermind and also one who performed a great service in making Abbe's work and methods known to others.

Although Abbe's theories are well known to-day, and the parts of the present volume which deal with them contain little that is unknown to English readers, the appearance of names like that of Prof. Moritz von Rohr amongst the collaborators is a sufficient guarantee that the new sections will not be lacking in originality. A case in point is the generalised treatment of the space presentation possible through different types of perspective and stereoscopic reconstruction in the use of binocular optical instruments.

The volume contains some twenty-one chapters, mostly of considerable length; some are highly mathematical and "condensed," while others are of a more descriptive character, in which the discussion is apt to be a little out of proportion with the general character of the work. The geometrical theory of instruments occupies the first ten chapters, a great deal of the treatment being similar to that which is now available in English through Mr. Kanthack's translation of the well-known book "The Formation of Images in Optical Instruments" (a symposium edited by Prof. von Rohr). The present work, however, has chapters on such subjects as diffraction phenomena and their relation to optical instruments, and the formation of images by non-spherical surfaces.

The last eleven chapters contain general discussions and descriptions of such instruments as photographic lenses, hand magnifiers, microscopes, projection apparatus, and telescopes. The important subject of practical optical measurements (curvatures, focal lengths, and the like) is unfortunately crowded into one chapter at the end, which will probably be difficult reading to any one who has not the knowledge necessary to supplement its brevity. The aim of the authors has apparently been not only to furnish a presentation of the theory and facts, but also to include, wherever possible, references to all known published work bearing on the subject in hand, together with some comment on the results described in the papers thus cited. The effect is naturally a very considerable expansion of the discussion; the book will occupy for optics almost the place that Kayser's famous "Handbook" has filled for spectroscopy. Hence it is bound to prove, for this reason alone, a most useful work of reference for a person already well acquainted with the subject generally.

On the other hand, the work should be avoided by the beginner. It is certainly no royal road to the design and computing of optical systems, for the trouble in work of that kind is to know "where to begin." It is to be feared that the average student would be in the same difficulty after reading its seven hundred pages, even if he found time to do so. He would also have some difficulty in deciding which were the parts of real practical importance and which were of merely mathematical interest. We are told at one place (p. 242) that if several bendings of a lens are taken and the spherical aberration is plotted against the curvature of the front surface, a parabolic law is found. A serious student should put the book down at this point and work out the formula numerically to obtain data to plot the curve. Unless this kind of thing is done, these formulæ are nothing but dancing figures.

No adequate attention is paid to the subject of the tolerances for aberrations. It avails little to be able to calculate the magnitude of a defect unless one has some idea as to what amount is allowable in relation to the particular circumstances. The truth is that formulæ expressing aberrations in terms of ray intercepts are quite unsuitable for the discussion of tolerances except in cases where these are comparatively large. The matter can only be dealt with satisfactorily, as Prof. Conrady has always maintained, by considerations of optical path.

It is, however, encouraging to find that the applications of the diffraction theory to the elucidation of the phenomena in the neighbourhood of a focus with or without aberration are beginning to receive the attention they deserve, and the necessary warnings are given on p. 238, where transverse aberration and diffusion circles are discussed. The diffraction theory of spherical and chromatic aberrations receives a separate chapter, but although the recent theoretical and numerical work carried out by Conrady and others in this connexion is mentioned, the results are not included. It would now appear that the statement on p. 313 regarding the effect of spherical aberration is incorrect. It is there maintained that increasing aberration will always diminish the resolving power of a lens system for an object like a double star. On the contrary, it has now been shown that a smaller central image disc may be produced slightly away from the ordinary focus under some degrees of spherical aberration; this will actually give increased resolution in spite of surrounding "haze." It need scarcely be said that this is a practical point of the greatest significance, for it shows that high resolving power is not necessarily a test of the best optical correction.

The equation  $n_h u = n' h' u'$  is now styled the Huygens Helmholtz equation! Has ever an equation received so many names? If the claims of R. Smith and Lagrange are thus passed over, it might be shorter to call it the Huygens equation and end the matter finally in this way. While speaking of names it might be pointed out that Mr. T. Smith, of the National Physical Laboratory, Teddington, the author of the papers to which references are given, should not be confused with Prof. T. T. Smith.

The lapse of a few more years will make the inclusion of full references an almost impossible task. Has not the time arrived when authors should have the courage to set forth clearly what they consider to be the essential parts of a subject without including matter which, for the majority of users of their books, has little more than mere theoretical interest?

L. C. MARTIN.

### Medieval Science.

*Studies in the History of Mediaeval Science.* By Prof. C. H. Haskins. Pp. xiv+411. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1924.) 28s. net.

THERE are few words which can evoke such a wealth and variety of reactions as "medieval." To the average man, perhaps, it recalls glimpses of illuminated missals caught in a brief walk through the British Museum; the poet will murmur *Donne ch' avete intelletto d'amore*, while the philosopher will dream dreams of the schoolmen and their interminable arguments. In the phrase "medieval science," however, many men of science of to-day will see nothing but a contradiction in terms, for it is a widespread idea that the Middle Ages stood for the very antithesis of all that is implied by the method and outlook of science as we understand it. Yet it requires but a little patience and insight to realise that, even in those remote and difficult times, the true spirit of science was awake and full of vigour.

The obstacle that so often prevents us from estimating early scientific work at its true value is essentially twofold. In the first place, only a fraction of the literature of the subject has been rendered easily accessible. To appreciate fully the labours of a medieval natural philosopher therefore entails no little research into original documents, a task for which few men of science have either the time or the inclination. Scholars and historians, on the other hand, are as a rule not interested in scientific literature, and even if they were, they usually lack the necessary knowledge of science. From this *impasse* there appears to be only one escape: historical research in science must receive full recognition as an integral part of science itself. We shall then very quickly attract the necessary men, and shall obtain results which will prove of incalculable benefit not only to science but also to the whole cause of human civilisation. A start in this direction has fortunately already been made at the University of London; other universities cannot afford to be left behind.

The second difficulty is not quite so easy of solution. In brief, it is that scientific thought is bound to vary, not merely in content, but also in form and character from age to age, for it must necessarily be influenced by the general intellectual background of the time. This influence is, of course, reciprocal, but if the philosophy and habits of thought of a particular age are very different from our own, we are inevitably led to judge the scientific work of that time by standards which are in reality quite inapplicable. In chemistry, for example, it is easy to place a true value upon the work of

Lavoisier and Dalton, for their ideas, aims and methods are fundamentally our own. It is much more difficult to appreciate the outlook and achievements of Becher and Stahl; our equipment of facts is so great that we find it practically impossible to denude ourselves sufficiently. When we go back to still earlier times, the difficulty becomes well-nigh insuperable. The whole intellectual *milieu* is foreign to us; we can understand neither the aspects of the problems which presented themselves nor the mental satisfaction of the solutions which were suggested.

An immediate key to this perplexing matter is that gift of sympathy which enables a man to transport himself to the Middle Ages and share the thoughts and aspirations of Gerard of Cremona, Adelard of Bath, and their contemporaries. This gift, alas, is all too rare, but if those who have it will translate their experiences into language intelligible to the rest of us, we may succeed in acquiring it at second hand. If, in addition to sympathetic insight, a man possesses also a sound scholarship, we may expect from him a flood of light upon medieval science. Such a man is Prof. Haskins, and his book justifies our anticipations.

As Prof. Haskins remarks in his preface, the history of European science in the Middle Ages is twofold. In the first place, it must deal with the recovery and assimilation of the science of antiquity in the course of the twelfth and thirteenth centuries; secondly, "it has to take account of the advance of knowledge by the processes of observation and experiment in western Europe." The scientific renaissance of the twelfth and thirteenth centuries was a very remarkable event, and at present very little is known about it, except that it certainly happened. Its importance can scarcely be exaggerated, for it appears that at least two new sciences were actually introduced into Europe during that time, namely, algebra and chemistry.

In the transmission of ancient learning from Islam to Europe, Englishmen played a prominent part. Adelard of Bath, for example, who has been called "the greatest name in English science before Robert Grosseteste and Roger Bacon," was a prolific translator of mathematical and astronomical works from the Arabic. Prof. Haskins has collected together all the available information about this rather shadowy figure, and we are surprised at both the extent and depth of Adelard's scientific knowledge. It is particularly interesting to learn that he shows the influence of the atomic theory of Democritus, for atoms were generally at a discount during the Middle Ages. He possessed a rationalistic habit of mind and subordinated authority to reason. "I call myself a man of Bath," he says, "and not a Stoic, wherefore I teach my own opinions, not the errors of the Stoics." Other Englishmen who

engaged in the task of translation were Robert of Chester (who is said to have translated for the first time a book on chemistry), Roger of Hereford, and Daniel of Morley.

Although the main stream of translations came from Moorish Spain, Prof. Haskins does not neglect the subsidiary sources. Some Arabic knowledge, for example, came direct from Syria; a great deal more was transmitted through Sicily, especially during the time of Frederick II., to whom and his famous astrologer, Michael Scot, two chapters in the present book are devoted. In spite of his busy political and military life, Frederick found time to take an intelligent interest in the scientific thought of the day, and had sufficient independence even to correct Aristotle when experience proved that the prince of philosophers was wrong—"we have followed him where required, but not in all things, for we have learned by experience that at several points he deviates from the truth." To disagree with Aristotle in the thirteenth century required a not inconsiderable moral courage. Frederick's experiments were numerous and occasionally startling, but they were always devised with a definite aim. He exploded the old fable that barnacle geese were hatched from barnacles by the simple expedient of sending north for some barnacles, while "whether vultures find their food by sight or by smell he ascertained by seeing their eyes while their nostrils remained open."

On Michael Scot, Prof. Haskins has a good deal new to say, and in many instances he is able to correct earlier writers. Scot worked both in Spain and in Sicily, and did much to make the *De animalibus* of Aristotle known to the Western world. His connexion with alchemy is doubtful, although many works on this subject are attributed to him. As an astrologer, however, he became famous throughout Europe. To test his skill in astronomy, Frederick ordered Scot to "calculate the height of the starry heavens—whatever that may mean—by the tower of a certain church, and then had the tower cut off somewhat and casually brought Scot back to the site. Scot took his observation and answered that either the heavens were more distant or the tower had sunk a palm's measure or less into the earth, both of which were impossible, whereupon the emperor embraced him in admiration of his skill."

Prof. Haskins, it will be observed, while writing primarily for the specialist, has seasoned his pages with many a pleasant anecdote, and the general reader may skip the footnotes (and the passages in Latin if he likes) and still gain profit and enjoyment from his reading. To the historian of science, however, the work will prove invaluable. The full bibliographical references alone are worth careful study, for Prof. Haskins knows

his literature, both printed and manuscript, as few others can do. The help which is provided in this direction will prove as attractive to the scholar as will the interesting information on falconry (Chaps. xiv. and xvii.) to the plain lover of the Middle Ages.

Medieval science, it is true, often appears to us to be puerile, but that is because we view it from the wrong angle. Our system of orientation has changed, but science is a living tradition firmly rooted in the past. Let us put ourselves in the place of these medieval men of science, and we shall form a better conception of their services to the cause. "La nature," says Hoefer, "est aujourd'hui ce qu'elle était autrefois. Les anciens avaient les mêmes yeux que nous pour la voir, mais ils n'avaient pas la même manière de la comprendre : la pensée humaine, voilà ce qui varie."

E. J. HOLMYARD

### Our Bookshelf.

*Department of Marine Biology of the Carnegie Institution of Washington.* Vol. 20: American Samoa. Part 1: Vegetation of Tutuila Island; Part 2: Vegetation of the Samoans; Part 3: Vegetation of Rose Atoll. By Prof. W. A. Setchell. (Publication 341.) Pp. vi+275+37 plates. (Washington Carnegie Institution, 1924.) 3.50 dollars.

THE Carnegie Institution has again maternally added to our knowledge of the vegetation of the more outlying parts of the world by the publication of three treatises on American Samoa by Prof. W. A. Setchell. The first and third parts are devoted to the vegetation of two islands, Tutuila and Rose Atoll, and provide a comprehensive review of the nature and distribution of the flora and enumerations of the species recorded. In addition to his own work, the author has incorporated that of previous workers in this locality, and has received the assistance of specialists in the description of the general habitat factors and the enumeration of the species.

In all too few cases have we records of this nature. Throughout the tropics our information on the vegetation is so frequently only to be found as a brief sketch in the introduction to an official handbook or guide. It is by the aid of such unit works as Prof. Setchell's that we shall gradually be able to obtain a due appreciation of the vegetation of such areas and, by piecing such units together, acquire sufficient knowledge to map out the vegetational areas and their connexions that are at present unknown. In each of these discussions the author has described the general habitat factors and then sketched the vegetation in its broader aspects and, where data have permitted, in more detail. This analysis has been based on the phanerogams recorded, for, as he remarks, our knowledge of the cryptogams is not sufficient at present to assist in this direction.

In an interesting review of the affinities of the Samoan flora, the author gives some negative characteristics which indicate the probability of an insular flora of the Pacific, though, as he points out, there is still much to be studied in this direction. Only eight new species

are recorded among the phanerogams, but there are a considerable number of new cryptogams, especially algæ.

The second treatise is devoted to the ethnobotany of the Samoans, and provides a record of the economic uses to which plants have been put. It is becoming more and more difficult, as civilisation transforms the habits of native races, to obtain such information, and any such records are to be welcomed.

An index of Samoan plant names is given in addition to the botanical index and greatly enhances the value of the work. There are thirty-six photographic reproductions in addition to text figures.

*The Ethnography of South America seen from Mojos in Bolivia.* By Erland Nordenskiöld (Comparative Ethnographical Studies, 3.) Pp. vi + 254 + 30 maps. (London: Oxford University Press, 1924.) 18s. 6d. net.

THE third part of Baron Nordenskiöld's comparative ethnographical studies of South America is in some respects the most interesting of the series. It is an illuminating example of the use to which, in skilful hands, distribution maps can be put in elucidating the cultural history of an obscure ethnographical area. In north-east Bolivia there is a large number of tribes, some belonging to recognised linguistic groups, others speaking isolated languages. The explanation of the considerable differences in culture among these is to be sought in their history rather than in the influence of geographical conditions which, broadly speaking, are identical throughout. The country consists for the most part of plains, which at one time in parts were subject to inundation. Hence mounds were erected for purposes of cultivation. The Seriono, who represent the most primitive stage among the tribes, alone raised no crops and subsisted by hunting. The tribes now have iron; the stone which they formerly used was all imported as there is none in the country. It is interesting to note that a stone-grinding industry still exists.

In his valuable analysis of their culture the author has plotted the distribution of such elements as dwellings, cultivation, hunting implements, weaving, fishing weapons, appliances connected with fire and the like. The result is a mass of valuable information relating to each. In addition a number of general conclusions emerge; thus while there are evidences of a cultural influence from the west and especially the north-west, only a few of the numerous elements of western culture which are found in the Chaco occur in N.E. Bolivia. As might be expected, the small tribes speaking isolated languages represent a very old stratum from which elements have been adopted by Arawak and Guarani. On the other hand, many of the tribes show signs of having been influenced considerably by the Guarani.

*Lighting in Relation to Public Health.* By Prof. Janet Howell Clark. Pp. 185. (Baltimore, Md.: Williams and Wilkins Co., 1924.) 4 dollars.

THIS book is intended to suit the needs of the public health worker, and is a recapitulation of the course of lectures delivered to students studying for the degree of doctor of public health at the Johns Hopkins University. The first four chapters deal with the technical side of illumination, and succeed in conveying a very good

account of the methods to be adopted in light measurement, and also of the advantages and disadvantages of the various illuminating systems, and one which easily can be followed without any special technical knowledge. The next three chapters deal with the questions of glare, sufficient illumination, and the best conditions for visual efficiency, the last including a brief account of the important work of Ferree and Rand on the measurement of ocular fatigue. Other chapters describe the best methods of illumination for schools, factories, and other interior and exterior purposes.

As regards intensity of illumination the author points out that though visual acuity, as tested by letter charts, increases with illumination and reaches a maximum at about 5 foot-candles, speed of discrimination increases rapidly up to 2 foot-candles and after that more slowly, but is still increasing at 18 foot-candles. Thus, in occupations where speed of discrimination is required, light up to 20 foot-candles may be employed with advantage. The remainder of the book gives a brief but good account of eye diseases attributable to light conditions, such recent work as that of Healy, Cridland, and St. Clair Roberts on cataract in tinplate millmen, iron-smelters, and chain-makers receiving mention. Some recent experimental work by the author on the coagulation of egg albumin by ultra-violet light is quoted as lending some support to Burge's theory on the causation of lens opacity.

We can cordially recommend the book as an adequate handbook to a subject that has only recently begun to obtain the attention it deserves. The publishers are to be congratulated on the excellence of both illustrations and type.

*Timbers: their Structure and Identification.* By W. S. Jones. Pp. xi + 148. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 15s. net.

THIS handbook is intended for forestry students who are engaged in a course of microscopical work on a selected group of timbers, comprising 24 European, 26 Indian, and 7 American broad-leaved trees, and 14 genera of conifers. The methods of preparing sections and microphotographs for the elucidation of structural details are carefully explained, as well as illustrated by 165 figures in the text. The lack of a comprehensive key to the whole of the genera is regrettable. The genera *Salix* and *Populus*, for example, are not distinguished in p. 73. It was scarcely worth while reprinting on p. 35 Hartig's inadequate key of forty years ago. An effort should be made in the next book that is published on the identification of timbers, to combine in one table the various keys that have been published of late years, notably Kawai's diagnosis of 200 species of Japanese broad-leaved woods and Kanehira's elaborate tables of 386 species of Formosan woods and 100 species of the more important Indian woods. Koehler's identification of North American woods, which appeared at Washington in 1917, might also be consulted. Without some such general view of the distinguishing characters of numerous species of woods, the palæobotanist, the archaeologist, the timber merchant and the furniture dealer are put to great inconvenience in determining with accuracy unknown specimens of woods. This handbook, nevertheless, may be recommended to students who are interested in the structure of timbers.

### Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.*]

#### Permo-Carboniferous Glaciation and the Wegener Hypothesis.

IN a recent number of *NATURE* (February 21, p. 255) there is a very interesting review by Prof. J. W. Gregory of an English edition of "The Origin of Continents and Oceans," in which important objections are brought forward against the supposed drift of continents and shifting of the earth's poles. The suggestion is made, however, that the theory will "probably give a new lease of life to the explanation of the Carboniferous glaciation of India and some parts of the Southern Hemisphere, by the shifting of the Pole; for arguments, which are unanswerable against that explanation with scattered continents, do not apply to Prof. Wegener's single continent."

The same view is held by Dr. du Toit, who has done excellent work in investigating the Dwyka glaciation in South Africa.

In preparing a forthcoming work on ancient glaciation, I have made a detailed study of the Permo-carboniferous ice age, and have reached conclusions which are quite at variance with this idea.

In the first place, it has been proved that ice sheets on all the continents supposed to unite about the south pole *reached sea level*. This is true of India, South Africa, South America and Australia, and in the latter two the ice touched the sea on both sides of the continent, as proved by fossiliferous marine deposits associated with the tillites.

The usual idea of a vast and lofty Gondwanaland on which an enormous ice sheet could arise must be given up, for the different glaciated areas were separated by oceans or at least by arms of the sea in which marine animals survived.

In the second place, an examination of maps of the supposed south polar continent prepared by Prof. Wegener (German edition) and Dr. du Toit shows an area of land far greater than Eurasia at present, with glaciation reaching a latitude of at least 45° on more than one lobe. In the case of South Africa, all the known ice motion was *southward*: and it is evident that the northern half of the African ice sheet has not yet been worked out, since the region is forest-covered and almost unexplored. It is altogether probable that ice reached as far to the north as it is known to have moved toward the south. This would carry the ice sheet at least ten degrees beyond the region mapped, say to latitude 35°.

It should be remarked further that, in most of the supposed Gondwanaland, as shown on the two maps mentioned, the glaciated areas would be far inland and out of reach of the moisture-laden winds necessary to deposit snow. They would be arid regions without permanent snow fields, like the interior of Asia, which was not glaciated in the Pleistocene though one of the coldest regions of the world.

It is evident, then, that the drift of continents and the shift of the poles do not help us to account for the Permo-carboniferous glaciation.

Prof. Wegener's account of the causes of Pleistocene glaciation is even less in accord with the facts. His arrangement of the shifting poles and continents gives Patagonia a mild climate while Canada was being glaciated, and allows the ice to invade South America

only at a much later time. A study of the American Pleistocene shows that two times of glaciation separated by an interglacial period occurred all the way along the Cordillera from Alaska to Tierra del Fuego, even Peru and Bolivia showing two sets of old moraines of different ages on the loftier peaks of the Andes. All geologists who have examined the Pleistocene deposits in South America as well as those of the north are agreed that they are of the same age and not separated by a million or more years as demanded by the theory of shifting poles.

It may be confidently stated that a careful study of the two greatest periods of glaciation known to geology gives no support to the theory of the drift of continents and the wandering of the poles.

A. P. COLEMAN.

University of Toronto.

I DID not mean to suggest that the lengthening of the life of the hypothesis would prove its truth, as I agree with Prof. Coleman in doubting the shift of the Pole in Carboniferous times; but the popularity of the theory will probably be increased by the removal of one line of argument against it.

J. W. GREGORY.

#### International Co-operation in Phenological Research.

THE response to our original appeal (*NATURE*, Oct. 25, 1924, p. 607) has been gratifying. Offers of co-operation range from Norway and Lithuania to Cape Colony and Australia; from Vancouver, Winnipeg, and Fargo (N. Dakota) to Lahore, Calcutta, and Batavia (Java). It has brought us into touch with many workers previously unknown to us, and ancient records, including an almost unbroken series carried on in the same family, on the same system, in the same place, from 1737 to the present day. We should like therefore to put forward for mutual discussion suggestions for future co-operation.

The plant observations made independently in different countries have been selected naturally from those best fitted for comparison with crop growth in the given country. In the same continent these lists include several common to all, allowing of a certain amount of inter-correlation. We must aim so to select the number that not only continental but intercontinental correlations will be established on a firm basis. When this is done, important equivalencies (such as Dr. A. D. Hopkins' classic example of wheat sowing and the Hessian fly) will become available over world-wide areas, where now they can only be applied locally, although he has already shown possibilities, particularly between the United States and Western Europe.

For this purpose we would suggest tentatively that an international list, including some forty subjects for observation, be drawn up, which might be expected to embrace at least some twelve to twenty fairly common in each of the associated countries, at least when situated in the temperate zones. Even ten, well distributed over the growing and fruiting months, would serve well for correlation.

For this purpose garden as well as wild flowers must be utilised, as being so widely introduced, though a number of the commonest are unsuited because of the many varieties in cultivation, and consequent variation in dates of leafing, blooming, and fruiting.

If such an international list is drawn up and each country collects and digests the results through its own Association, then in ten years or so statistics

will have been brought into existence adapted to international comparison and the time will have come for the yet closer international co-operation already established in allied natural sciences such as meteorology.

Meantime each country would continue its present series of observations, while the observing members would be invited to observe also, either as a separate series or embodied in their own lists, a selection from the international list most available and not already under observation.

That there may be a basis for discussion the following list has been drawn up from those actually in use in Italy, the Tyrol, Central Europe, and Great Britain. Criticism and alternative suggestions will be highly valued.

#### PHENOLOGY AND AGRICULTURE.

Suggested observations to correlate series A and B.

##### A. FARM GROWTH PHENOMENA.

- (1) *Grain crops*: dates of sowing (autumn and winter), appearance, ears showing, flowering, harvesting.
- (2) *Root crops*: (say sugar beet) sowing or planting, appearance, digging.
- (3) *Meadow hay*: flowering of sweet vernal grass (*Anthoxanthum odoratum*) and Timothy grass (*Phleum pratense*); hay-cutting.

##### B. FLOWER PHENOLOGY of wild and garden flowers of wide distribution. Tentative list arranged by approximate date (day of year) of flowering in Great Britain.

	Common and Botanical Names.	Day of Year
1	*Snowdrop ( <i>Galanthus nivalis</i> )	19
2	†Winter aconite ( <i>Eranthis hiemalis</i> )	20
3	Yew ( <i>Taxus baccata</i> )	30
4	†Yellow crocus ( <i>Crocus aureus</i> )	33
5	Common elm ( <i>Ulmus campestris</i> )	44
6	*T. . . . .	44
7	* . . . . .	47
8	*Coltsfoot ( <i>Tussilago farfara</i> )	65
9	Cherry plum or purple variety ( <i>Prunus cerasifera</i> or var. <i>P. pissardi</i> )	70
10	Bracken ( <i>Pteris aquilina</i> (shows))	80
11	Almond ( <i>Prunus amygdalus</i> )	85
12	White poplar ( <i>Populus alba</i> )	85
13	Black poplar and Lombardy poplar ( <i>Populus nigra</i> and var.)	90
14a	*Wood anemone ( <i>Anemone nemorosa</i> )	92
14b	Goat willow ( <i>Salix caprea</i> )	100
15	*Blackthorn ( <i>Prunus spinosa</i> )	102
16	Flowering currant ( <i>Ribes sanguineum</i> )	110
17	. . . . . oak ( <i>Quercus robur</i> )	115
18	. . . . . oak ( <i>Quercus pedunculatus</i> )	115
19	. . . . . ( <i>Ribes rubrum</i> )	115
20	* . . . . . mustard ( <i>Alliaria officinalis</i> )	120
21	. . . . . ( <i>rus malus</i> )	130
22	. . . . . ( <i>Æsculus hippocastanum</i> )	133
23	Common lilac ( <i>Syringa vulgaris</i> )	130
24	Quince ( <i>Cydonia vulgaris</i> )	135
25	Laburnum ( <i>Cytisus laburnum</i> )	138
26	*Hawthorn . . . . . ( <i>cantha</i> )	139
27	Raspberry . . . . .	150
28	*Ox-eye-daisy ( <i>Chrysanthemum leucanthemum</i> )	154
29	Elder ( <i>Sambucus nigra</i> )	160
30	*Dog rose ( <i>Rosa canina</i> )	163
31	Snowberry ( <i>Symphoricarpos racemosus</i> )	165
32	Gelder rose ( <i>Viburnum opulus</i> )	165
33	*Black . . . . . ( <i> . . . . .</i> )	190
34	. . . . .	195
35	*Greater bindweed ( <i>Convolvulus sepium</i> )	198
36	Sweet chestnut ( <i>Castanea vesca</i> )	200
37	Montbretia ( <i>Tritoma montbretia</i> )	200
38	Autumn crocus ( <i>Colchicum autumnale</i> )	245
39	Autumn Caucasian crocus ( <i>Colchicum speciosum</i> )	250
40	*Ivy ( <i>Hedera helix</i> )	276
41	Winter (yellow) jasmine ( <i>Jasminum nudiflorum</i> )	280
42	Christmas rose ( <i>Helleborus niger</i> )	350

\* These twelve are in the Roy Met. Soc. chief phenological list, observed from 1891.

† In supplementary list.

Even if only a dozen can be used, their value would be material.

*Grain Crops*.—Possibly the British Ministry of Agriculture will supply agricultural colleges, etc., every year with seed specially grown. Every year

the various stages of a given sort should be observed on the same plot.

For No. 22, and if possible with other trees, the leafing, fruiting, colouring, and leaf-fall of the same specimen or group should be recorded.

No. 9. On seven years' records at Purley these were identical in average date.

Nos 17 and 18. Which is most widespread?

No. 26. In more southern areas, as Tyrol and Italy, unfortunately displaced by the later *C. monogyna*.

As ushering in the second quarter of this century, 1926 naturally suggests itself as an appropriate year for starting such co-operation. Work would therefore begin next December in the northern hemisphere, and the following June in the southern.

One very valuable help at the present stage in criticising the list will be to forward us the names of such of the forty or so as could and would be observed in different districts and countries.

J. EDMUND CLARK,

Sec., Roy. Met. Soc. Phenological Committee.  
Royal Meteorological Society,  
49 Cromwell Road,  
South Kensington,  
London, S.W.7.

#### Depth-recording with Plankton-nets.

It is well known that there is great variation in the vertical distribution of various plankton organisms, but up to the present the actual depths from which net-collections have been made has never been known with certainty. To help in the study of the vertical distribution of marine zoo-plankton, the Admiralty very kindly sanctioned the loan of an instrument which records graphically, on a drum worked by clockwork, the depth at which a net has been fishing during the whole of its period under water. Results obtained with this apparatus indicate the necessity for an accurate knowledge of the depth at which the net has fished.

While collecting last year I used the recorder regularly, and a few facts have come to light as to how the net behaves when fishing.

The net in use was that known as the ring-trawl, a conical bag 9 metres in length, with a diameter of 2 metres at the mouth. It was made of "stramin" (hemp-sacking *ca.* 16 strands to one inch). To the end of the net was attached a galvanised iron bucket. It was towed on a single warp of 2-inch (circumference) wire from the port drum of the large trawl winch. At the junction of the bridle with the warp was attached a weight of  $\frac{1}{2}$  cwt on a short length of rope, and at this junction also was fixed the depth-recorder.

When a net is being towed, there are three main forces in action: the forward and slightly upward pull of the boat, the downward pull of the weight, and the backward pull of the net, wire, etc. Whereas the force due to the weight is constant from day to day, the two remaining forces depend upon the rate at which the net moves through the water; this in turn is dependent upon the rate of the towing-ship through the water, not over the ground, and the clogging of the meshes of the net. The speed of the ship through the water is influenced by the strength of the wind and, when the net is fishing deep, by the drift, if any, of the surface water relative to the deeper layers.

The ship from which we work is a large wooden steam-drifter, the s.s. *Salpa*; when fishing with the above net the engine is used as motive power, except when the wind is so strong that it is possible to drift. The ship generally steams with the wind behind, because if she towed against the wind at the slow

speed necessary, she would be constantly falling off to either side, so necessitating extra manœuvring to prevent the warp coming under the stern and fouling the screw.

Under favourable conditions the engine is run dead slow; that is, as slow as it will run without stopping. It is the practice for the captain, as near as he can judge, to keep the angle of entry of the warp into the water constant (*ca.*  $40^\circ$ ). It is probable that by this means the filtering of the net will be as nearly the same as possible from day to day, as it must mean that the speed of the net through the water is fairly constant, and catches made on different days should therefore be comparable quantitatively.

This constant speed can be kept by adjusting the revolutions or actually stopping the engine for a few moments as the angle of the warp changes.

Working in this manner through a large number of hauls, the graphic records of depth of fishing have

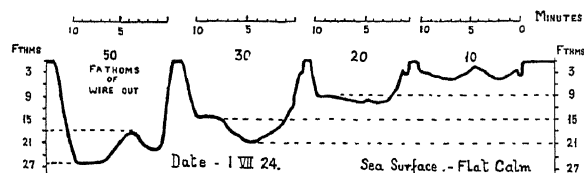


FIG 1

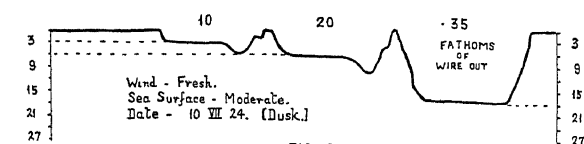


FIG 2

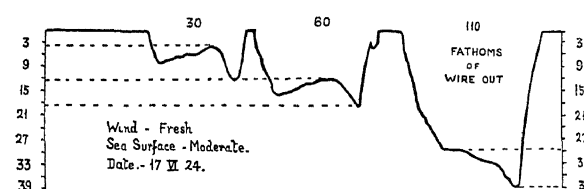


FIG 3

FIGS. 1, 2, and 3 are tracings of records obtained during three series of hauls. Each haul, represented by a curve, is of ten minutes' duration (time of "shooting" and "hoisting" not included). The net enters the water on the right-hand side of the curve. Above the curve for each haul is inserted the depth of fishing in fathoms.

shown very varying results. On some occasions the net has followed a wavy path, fishing through as great a vertical range as 9 or 10 fathoms; on others, the level kept by the net has been as perfect as could be wished for. Further, the seemingly paradoxical facts have arisen that on a day when the sea surface was like glass and conditions seemed most favourable, one of the worst results was produced; whilst under conditions of wind and swell such that work was almost abandoned, and furthermore in semi-darkness, the level kept by the net was as good as any obtained. These two instances are illustrated in Figs. 1 and 2; these tracings represent two series of hauls each of ten minutes' duration, and should be read from right to left, the net entering the water on the right-hand side of each curve and leaving it on the left. In Fig. 1 the haul with 30 fathoms of wire out is an example of a bad result: in this instance the net began fishing with the engine at the usual "tow-net" speed, but after five minutes, the angle of incidence

of the warp appearing visibly greater than that usually kept, the engine was speeded up slightly, with the result that the net, which had sunk to 21 fathoms, was now slowly raised to a level of 15 fathoms, where it remained until the end of the haul. This behaviour is a little hard to understand when we look at the haul with 20 fathoms of wire out, here the net was towed with the engine at the same speed as at the beginning of the haul we have just examined, but instead of sinking, as it did on that occasion, it remained nearly level, rising very slowly throughout the duration of the haul.

Fig. 2 illustrates the curiously perfect results obtained in very unfavourable circumstances.

It seems quite probable that if no attempt be made to adjust the angle of incidence with the engine, the net will find an equilibrium level, under the weather conditions prevailing at the time, and will fish there. This may account for the good results shown in Fig. 2, in which case the equilibrium level was found when the warp was at the angle usually aimed at. Therefore to fish a net at a constant level under different conditions of wind and sea, the length of warp required to keep the net at a given depth will vary considerably; how much this variation may be has been shown by some of my results. For example, in Fig. 1, in the haul with 30 fathoms of wire out, if the warp had not been watched and the net had been allowed to find its own level, it would possibly have sunk deeper than it did; as it was, it had reached a depth of 21 fathoms, and this with 30 fathoms of wire out, so that the ratio of depth to warp out was 2 : 3. In Fig. 3, however, with a very fresh wind blowing, it was not possible, even without the engine, to keep the angle of incidence of the warp anywhere near that at which we usually aim. If we look at the curve for 30 fathoms of wire out, we find that on one occasion the net rose as high as 4 fathoms; this gives a ratio of 2 : 15, very different from that cited above.

In two cases the angle of incidence of the warp was measured as accurately as possible, and in both cases the depth estimated from the angle, on the assumption that the warp followed a straight line from the ship to the net, was very different from that actually shown by the recorder; in one case the estimated depth was 20 fathoms and the actual depth 14.

From the above results it would seem that with large tow-nets of the type used in this case, it is impossible to estimate the depth of the net with a sufficient degree of accuracy, at any rate for coastal work on plankton distribution. Possibly with small nets, a weight out of all proportion to the size of the net will keep the wire nearly vertical and the net steady, but with large nets like the ring-trawl, the weight would of necessity be too great for man-handling in everyday work.

This would point to the necessity of having some simple and easily manipulated recorder designed of small enough size to be used when a string of nets is being fished.

F. S. RUSSELL.

The Laboratory, Citadel Hill,  
Plymouth, February 25.

#### Spectroscopic Evidence of J-Transformation of X-rays.

The relation between the atomic number of a radiator and the wave-lengths of its X-ray emission spectrum of *K*-series is generally assumed to be the regular one described by Sommerfeld's extension of Bohr's idea to X-ray spectra. Well-marked irregularities, however, have not received attention in

the literature of the subject; it is the object of this note to direct attention to them.

Fig. 1 shows the variation of the wave-lengths  $K\alpha_1$ , and  $K\alpha$  (absorption limit) with atomic number ( $Z$ ) of radiator from  $Z=40$  to  $Z=60$ ; the plotted values

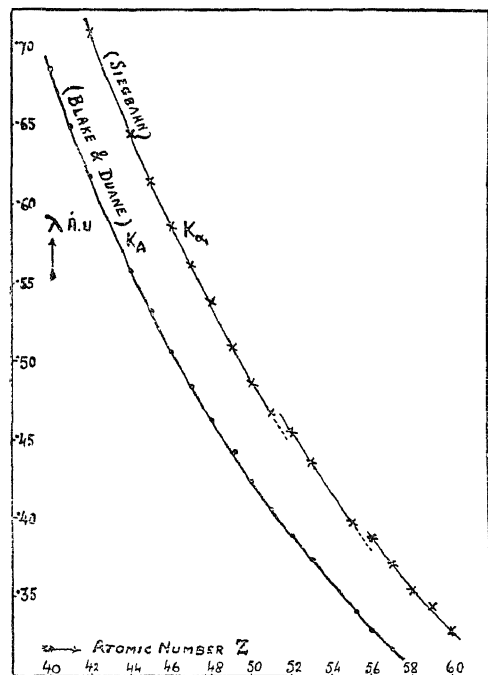


FIG. 1.

are from Siegbahn, and Blake and Duane respectively. Fig. 2 is an enlargement of Fig. 1, to show more clearly the irregularities which we shall proceed to describe. If we follow  $\lambda$  for  $K\alpha_1$ , as  $Z$  is increased

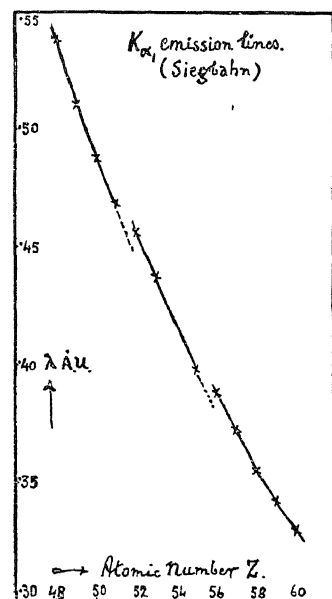


FIG. 2.

from 40, we notice that at  $Z=52$  and at  $Z=56$  there takes place a sudden increase in  $\lambda$  relative to the value which would have occurred, were the simple relation for smaller atomic numbers obeyed. The magnitude of this excess is about  $0.01 \text{ \AA.U.}$  in each case. Exactly the same irregularities occur in  $K\alpha_2$  and  $K\beta$ , but not in  $K\alpha$ . Lack of data prevents any definite conclusion with regard to  $K\gamma$ . The degree of precision claimed for these spectroscopic observations is too high to admit of any other conclusion than that these irregularities are real deviations from the simple law.

It is certainly no fortuitous coincidence that

the wave-lengths at which these sudden increases take place, correspond very well with two of the critical absorptibilities for  $J$ -transformation, which in the case of aluminium are  $(\mu/\rho)_{Al}=1.9$  and  $0.7$  (see Bakerian Lecture by Barkla, *Phil. Trans.*, 1917, and Barkla and White, *Phil. Mag.*, 34, Oct. 1917), and are only

very slightly displaced by change of the atomic number of the transmitting element except when this is small. The atomic structure of the radiator cannot be supposed responsible for the irregularities referred to, for, at the atomic numbers indicated, there is no readjustment of electronic distribution according to the Bohr scheme. As there is no reason, either theoretical or practical, for the occurrence of these irregularities, apart from the  $J$ -transformation, and as they appear precisely in the same place as in the experiments showing  $J$ -discontinuities, one can only conclude that these irregularities are due to the  $J$ -transformation of X-radiation taking place in the calcite crystal used for the analysis of the radiation or possibly in the anticathode or walls of the X-ray tube. We have, however, no information of the crystal used by Blake and Duane for the measurement of  $K\alpha$ .

This seems to be the first spectroscopic evidence of the  $J$ -transformation, which by absorption methods has been found in primary rays (Barkla, Silvanus Thompson Lecture, *NATURE*, Nov. 22, 1924) and in scattered rays (Barkla and Khastgir, *Phil. Mag.*, 49, Jan. 1925). This also strongly supports the view expressed by Barkla (*NATURE*, Nov. 17, 1923, and Nov. 22, 1924) that the apparent increase of wave-length as observed by Compton and others in the scattered radiation is due to the same  $J$ -transformation during transmission in the crystal or in the radiator, and is not part of the phenomenon of scattering at all. That the magnitude of the change appearing in the curves shown here is of the order of the Compton shift, gives further support to this contention. It must be understood, however, that the attainment of a critical wave-length is not the only factor which determines whether or not the transformation takes place.

S. R. KHASTGIR.  
W. H. WATSON.

Physical Laboratory,  
University of Edinburgh,  
March 27.

#### Acidity produced in Salt Solutions by Sphagnum.

THE fact that Sphagnum or peat shaken with a neutral salt gives rise to an acid reaction in the solution has long been known. Baumann and Gully first explained this phenomenon as due to the adsorption of the base by colloids and the liberation of the acid. This view has been the subject of much criticism, especially by Odén, who regards the acidity as due to the presence of organic—humic—acids. An important argument of Odén is that no proof has been offered that the acid of the salt employed is ever present in the free state in the solution. We have been able to provide this proof by two different methods.

If a weak solution of copper chloride (0.025 per cent.) is shaken with Sphagnum it becomes acid to methyl orange. Colorimetric estimation shows that 75 per cent. of the copper has disappeared: determination of the chloride shows that it is still present in the original strength. The presumption is strong, therefore, that the acidity is due to free hydrochloric acid. As, however, the free acid, as estimated by titration, does not account for the whole of the chloride, the proof is not definite. It has been found that a secondary reaction resulting in the neutralisation of part of the acid takes place.

When the sodium salts of different acids are shaken with Sphagnum, different amounts of acid are liberated; much more acid is liberated from the acetate than from the chloride. It was found, on the other hand, that the hydron concentration was much greater in the second case than in the first. The exact results for a

series of salts may be given. In each case 1.5 gm. of *S. cymbifolium* was shaken with 100 cc. of N/10 salt. The acid was titrated with sodium hydroxide, and is expressed as a fraction of normality. The borate was titrated after addition of manitol. The hydron concentration was determined colorimetrically.

Acidity produced in salt solutions by *Sphagnum cymbifolium*.

Salt (N/10).	Titration Value.	P <sub>H</sub> Value.
Sodium chloride . .	0.00026	4.6
Sodium sulphate . .	0.0005	4.6
Sodium acetate . .	0.0065	5.5
Sodium citrate . .	0.0085	5.9
Sodium borate . .	0.015	9.4

The fact that high titration value goes with low hydron concentration is very suggestive. A solution of sodium chloride and hydrochloric acid having the titration value shown was prepared and corresponding salt-acid mixtures of the other salts employed. The hydron concentrations of these were determined, and were found to be 4.6; 4.6; 5.5; 5.9; 9.5, respectively. The agreement is very satisfactory, and seems to give definite proof that the acid present in the salt solution after shaking with *Sphagnum* is, in fact, the acid of the salt employed. The explanation of Rice, that a similar phenomenon in soils is due to the formation of acid aluminium salts, does not appear to be applicable here. The further implications of these results will be dealt with in a later communication.

MACGREGOR SKENE.  
GLADYS L. STUART.

Botany Department,  
University of Aberdeen,  
April 3.

### Three Cases of Abnormal Anterior Abdominal Veins in the Frog.

THE abnormalities here described were discovered during class dissection in this College. Of fifteen specimens dissected three showed abnormality in the anterior abdominal vein. All three specimens were females.

Specimen A. The anterior abdominal vein had no connexion with the liver, but emptied itself into the left subclavian vein.

Specimen B. Similar to A. In addition there was a transverse anastomosis between the external jugular veins.

Specimen C. The anterior abdominal vein sent a small vessel to the liver, but most of the blood passed into the right subclavian vein.

The abnormal specimens showed no other peculiarities.

Communications between the anterior abdominal vein and the right or left subclavian veins have been recorded by four observers, of whom three found one specimen each. Buller (*Journ. Anat. and Phys.*, vol. 30, 1896) found in a female specimen a condition similar to C, but opening nearer the heart, namely, into the superior vena cava at the entrance of the subclavian into it. Woodland (*Zool. Anz.*, Bd. 35, 1910) described the first abnormality (A) in a male frog, and O'Donoghue (*Zool. Anz.*, Bd. 37, 1911) the same condition in a male specimen, coupled, however, with an abnormal heart. Lastly, Collinge (*Journ. Anat. and Phys.*, vol. 50, 1915) reported one case in which the anterior abdominal vein gave off a large branch to the hepatic portal system and then sent a

fine vessel into the right anterior vena cava, and another case where both right and left venæ cavæ received contributions, no blood going to the liver from the anterior abdominal vein. The abnormalities here in question are probably of rare occurrence, and it is surprising to find them in 20 per cent. of a batch of frogs (3 out of 15).

The interest of the abnormality, as was pointed out by the above writers, lies in the fact that it represents a persistent embryonic feature. The anterior abdominal vein of the adult frog originates by the fusion of a pair of larval veins carrying blood from the hind limb to the sinus venosus. Posteriorly the fusion is complete, anteriorly the right vein usually disappears, the left loses its connexion with the sinus venosus, and a new connexion is acquired, namely, with the hepatic portal system. The specimens A and B, therefore, show a loss of the right anterior portion of the ventral vein, have retained the connexion with the sinus venosus through the subclavian vein of the left side, but have not acquired the communication between the fused posterior veins (anterior abdominal) and the hepatic portal system. In specimen C, the left vein of the pair has disappeared, the communication with the sinus venosus remains, and the hepatic portal connexion has been acquired. Specimen A has been placed in the Museum of the Zoology Department of the College.

NELLIE B. EALES.

University College, Reading,  
February 27.

### The Life-History of *Amœba*.

SINCE the full details of some experiments on *Amœba proteus* carried out upon numerous strains of *Amœba*, each strain descended from one single individual, will not be forthcoming for some time, it seems advisable to make a preliminary announcement of the following results obtained by my assistant, Miss Isabelle P. McGuire.

On November 23, 1923, five glass dishes, ranging from 3 to 6 inches diameter, and height 3 inches, were provided with 50 c.c. of Glasgow tap-water, and 2 to 5 wheat grains, according to the capacity of the dish. These were left in a warm room over-night. On November 24 one adult *amœba* from Culture 11 (*Q.J.M.S.*, Vol. 69, Part I., Dec. 1924), plus about 25 c.c. of the culture water plus some food organisms upon which *A. proteus* feeds (these latter being carefully scrutinised and identified before being used), was inoculated into each of the prepared aquaria, care being taken to see that no minute *amœbæ* were included. Each dish was then covered with a glass plate and put into a warm (temp. 60° F.) shady place. Tap-water was added gradually until each aquarium became full of liquid. One wheat grain was added to each on the following dates: March 23 and June 10. Two wheat grains were added to each on July 4 and September 9.

In February and March 1925 the aquaria were examined. None of them contained adult *amœbæ*. In two of them, however, a population of small *amœbæ* were seen—recognisable under a  $\frac{1}{8}$ -inch objective. In two others encysted young *amœbæ* were visible amongst the debris. A few of these were transferred to a slide, and were kept in a damp chamber from March 12 last until March 16, on which date young *amœbæ* hatched out of the cysts. The fifth aquarium was a blank: no *amœbæ* or encysted young *amœbæ* were found.

Since Miss McGuire is working in Notre Dame Laboratory, where cultures are constantly set up, it

was not deemed necessary to have control experiments other than those employed for the general culture work. It has been observed over and over again that an aquarium inoculated with food organisms only does not produce a population of *Amœba proteus*. In my prolonged work upon the life-history of *A. proteus* I have failed to find any evidence of the occurrence of syngamy in its life-history, and it is clear that the experiments now recorded greatly increase the probability that no such process occurs in the normal life-cycle of *Amœba proteus*.

MONICA TAYLOR.

Notre Dame,  
Dowanhill, Glasgow.

#### Total Intensity of Scattered X-radiation.

In a report by Duane (Proc. Nat. Acad. Sci. 10, 378, 1924) mention is made of the intensity of scattered radiation inside a closed box containing an X-ray tube. He states that "the amount of this box radiation that passes out through the slits into the spectrometer appears to be sufficient to dominate more or less completely the spectrum obtained." He then cites a number of instances where remarkably intense scattered radiation has been observed.

We offer the following instance as additional evidence of the comparatively large intensity of the scattered radiation inside a closed room containing an X-ray tube.

A Coolidge tube with a molybdenum target, which was operated at about 5 ma. and 25 kv. peak, was placed in a room about 22 × 25 feet and 10 feet high. The tube was located about 2 feet from one side and equidistant from the ends of the room. The height of the tube above the floor was about 4 feet. We observed that a photographic film placed some 50 cm. from the tube and shielded from the direct rays by proper lead screens was almost completely blackened in three minutes. We also found it possible to observe the scattered radiation at distances so great as two metres from the tube by means of a fluoroscope, the direct radiation being cut out by a sheet of lead placed directly in front of and in contact with the fluoroscope. This indicates that the intensity of the scattered radiation inside the room is nearly of the same order as that of the direct radiation. However, in this experiment, as in the cases cited by Duane, the effect of the scattered radiation is integrated over a solid angle of  $2\pi$ . The solid angle in the case when the radiation proceeds through slits is much less than  $2\pi$ , and so the intensity is probably not sufficient to modify the scattered spectrum as Duane suggests.

O. K. DEFOE.  
W. W. NIPPER.

Washington University,  
Saint Louis, Missouri,  
February 12.

#### The Auroral Green Line.

DR. SHRUM and I have found that the line  $\lambda = 5577$ , which we think is identical with the auroral green line, can be obtained with a mixture of oxygen and helium (with the latter greatly in excess), just as intense at room temperatures with a suitable pressure as when the discharge tube is surrounded with liquid air. Moreover, the results of our experiments strongly indicate that this spectral line has its origin in oxygen.

J. C. McLENNAN.

The Physical Laboratory,  
University of Toronto,  
April 4.

NO. 2895, VOL. 115]

#### The Mortality of Plaice.

I KNOW of no facts in the natural history of male plaice which would render untenable the logically flawless hypothesis of Dr. Bidder (NATURE, April 4), to the effect that it is what he calls "parental death" which occurs in this sex. In females the question of parental death is still in doubt unless "as the fish grows larger" (I quote Dr. Bidder) " $\frac{1}{2}$  diminishes, and reaches 1.0 at a constant ratio of ovary-weight to body-weight which allows the residual body to recover after spawning." In this connexion I can only state that one occasionally encounters greatly emaciated very old females (called by fishermen "slinks") which have all the appearance of not being "long for this world." This observation, however, merely suggests that in the largest fish "ovary-weight may bear a lethal ratio to body-weight," the possibility of which is admitted by Dr. Bidder.

Perhaps I may now be permitted to suggest to Dr. Bidder one possible implication of his hypothesis as to the non-liability of the females to either parental or senile death. One consequence on an unfished area might be that the area would tend to become monopolised by a comparatively few females of immemorial antiquity, prodigious size, and devastating activity (since the larger the size the greater the activity necessary to procure food to maintain it). In these circumstances the adolescent females and mature males, necessarily restricted in their diet to the smaller molluscs, etc., would not stand a chance against the voracity of the giant "methuselahs" with their capacity for ingesting and digesting both large and small organisms. I suggest that this competition *intra* species would prove fatal to its existence.

WILLIAM WALLACE.

Fisheries Laboratory,  
Lowestoft,  
April 7.

#### Robert Browning as an Exponent of Research.

In "Robert Browning as an Exponent of Research" (NATURE, February 28, p. 298) why was it written?

"As still to its asymptote speedeth the curve."

The curve itself is full of exponents, but is it asymptotic? Is it continually *more slowly* approaching the right line? I prefer to interline and excerpt rather than expect pure science of good poets.

Browning wrote:

"But God has a few of us whom he whispers in the ear"

and

"He fixed thee 'mid this dance of plastic circumstance,

This Present, thou forsooth, wouldst fain arrest:  
Machinery just meant to give the soul its bent," etc.

and finally

"This man decided not to Live but Know.

Bury this man there? . . .

Leave him—still loftier than the world suspects,  
Living and dying."

W. R. WHITNEY.

Schenectady, N.Y., U.S.A.,  
March 15.

## Physiology and "Vital Force."

By Prof. FRASER HARRIS, M.D., D.Sc.

EFFORTS in the past to account for the mysterious powers and properties of living beings have in the main consisted of bringing in some supra-sensible, immaterial, ultra-cognisable "principle" or "entity" as the *causa causans*. This has been known under different names as time went on, but they have all referred to the same thing—psyche, pneuma, the anima sensitiva of Van Helmont, the life principle of Stahl, the Bildungstrieb of Blumenbach, the vita propria of Bordeu, the vitalis agens of Barthez, the Lebenskraft of Reil, the entelechy of Driesch, the élan vital of Bergson, and the biotic energy of Moore. It is of the essence of vitalism to explain life in terms of the less known, to account for the properties of a living being by the indwelling activity of an entity, agent, or force which, by its very metaphysical nature, is inaccessible to human investigation.

To assert that each organ, tissue, and cell is as truly alive as is the whole organism is not "vitalism," but a correct physiological observation, for the isolated organ, heart or liver, can perform its vital functions long after separation from the body to which it belonged; and the cell taken from its tissue can live for years, as Ross Harrison and Carrel have proved, in its morphological isolation. To say these organs have an independent life (whether it is said in English or in Latin *vita propria*), is to report an observation; to say that life is due to a "life force" or "entelechy" is to state a theory.

If the vitalists had always been careful to admit that their view was only a theory of life, much acrimonious discussion would have been avoided; but when they declared that theirs was the only right view, their virtual claim to omniscience failed to arouse in many minds the enthusiasm expected. These unconvinced people tried to explain life in terms of what they knew at least a little about—the non-living world around them; and they were in consequence called materialists and their theory mechanistic. Now theirs is a theory no less than is the vitalistic. The materialistic theory is that the observed known—the properties and behaviour of living organism—may be explained by applying to them our knowledge of the laws and properties appertaining to the non-living world. It is an explanation of the known in terms of the more known rather than the less.

The term "materialist" ought not to be used as one of reproach; the materialist is almost always a sincere searcher after truth, who, starting from his colleague the physicist's knowledge of the properties and behaviour of non-living matter, attempts to apply these to the behaviour of living matter. He finds that many of the laws that hold good in the world of the non-living seem to be equally applicable to that of life. In particular, he finds that vital heat, for example, is not in its essence different from heat of non-vital origin, that the great generalisation of the conservation of energy holds good for the mammalian body, that "vital" processes are accelerated by a rise, and retarded by a fall, in temperature exactly like "purely" chemical reactions in a test-tube. He is able to say in the language of his chemical colleagues that living

matter (protoplasm) behaves in many respects like an irreversible colloidal emulsoid hydrosol.

The materialist found, as a matter of fact, that so many vital activities seemed to be the outcome of the operation of laws already proved true for the non-living universe, that he finally made so bold as to assert—and here he made the first mistake—that the mystery had vanished, and that protoplasm, chemically speaking, was only an excessively complicated form of matter. To this view Loeb committed himself. He wished us to believe that he had proved that the dividing line between the non-living and the living had been removed, and that we might pass by a number of gradations from physico-chemical simplicity at one end of the series to great physico-chemical complexity at the other. Somewhere on the way one passed from the non-living to the living.

Here the materialist went beyond what his premises allowed him; in this he was rash; but rashness inheres in the enthusiasm of youth, and biology is a very young science. But the vitalist had always been rash for exactly the same reason; he had gone beyond experience. He had asserted that urea and sugar could never be made without the agency of life, because he had never found these substances anywhere except in living animal or vegetable tissues. When, therefore, in 1828 Wohler made urea in a test-tube, and in the 'eighties of last century Fischer synthesised sugars, and when indigo was produced that had never seen a plant, and when the hormone adrenalin was constructed artificially, vitalism received a set-back, and materialism a corresponding encouragement. The anti-vitalistic view was further strengthened by the discovery that many ferments, solely the products of life, dealt with their "substrates" exactly like the inorganic catalysts so well known to chemists. Finally, when Loeb caused the unfertilised eggs of the sea-urchin, either by altering the density or composition of sea-water, to begin to undergo development, the days of vitalism seemed numbered.

The materialist has, indeed, shown us how the plant is able to synthesise a carbohydrate from carbon dioxide and water through the stage of formaldehyde; but he himself is very far indeed from making a scrap of nucleated protoplasm, and until he does that, since we know no life apart from nuclei, it seems exceedingly improbable that he will be able to synthesise any kind of living substance. The materialist goes far beyond his observations when he maintains that the laws of the non-living world are the only laws which operate in the sphere of the living. It is one thing for them to operate there, it is another for them to operate *alone*.

Life and living things are *sui generis*. It is better to admit at once that so far as our experience goes up to this hour, life is unique. Prof. J. A. Thomson gives the following features of the uniqueness of living matter thus (Gifford Lectures, St. Andrews, 1915-16):

1. Its capacity for enregistering experience which, in the hereditary relation, is an expression of physiological inertia.

2. The self-maintaining tendency of the organism.

3. Its variability, or the capacity to give origin to the new.

Living matter can do what no non-living matter can—assimilate material wholly unlike itself; evolve from a minute and relatively homogeneous speck into an obvious and heterogeneous organism; reproduce its kind either by casting off buds or by gametes; pass through a life-cycle of irreversible stages, from infancy to youth, maturity, senescence, and death.

So far as we can judge, the higher animals possess a variety of energy, nerve-energy, which also is *sui generis*. Finally, in the realm of the living we encounter those phenomena called subjective, the world of consciousness with all its modes—sensation, emotion, volition—a world which, so far as we know, never exists apart from living matter, and is absolutely unique.

Certain critical vitalists sometimes blame physiologists for investigating living things by the methods of chemistry and physics. The late Sir James Mackenzie wrote (*British Medical Journal*, March 1, 1924): "Physiologists place the organ in artificial conditions, employ artificial stimulation and obtain artificial results . . . such as the all-or-nothing law."

Now this criticism is rather hard to bear, because we have no methods or apparatus other than these "artificial" ones. Although the biologist is investigating phenomena that are *sui generis*, he has unfortunately no apparatus which is adapted exclusively to biological use. The physiologist uses test-tubes, retorts, induction-coils, and galvanometers because there are no two kinds of instruments, one for biologists, and one for physicists. It is rather hard that, having been forced to use these things and having by so doing obtained results valuable to medicine, he should be stigmatised as a materialist.

When we speak of the mechanism of gastric digestion, we merely use the expression as a conveniently short one for all those processes which are involved in the vital manufacture of pepsin and hydrochloric acid from neutral blood, their separation through and by the mucous membrane, and their solvent action upon food in the interior of the viscus. Nothing more "mechanical" is meant than this, and this is not mechanical at all. Only the last process, the solution of the protein, can go on *in vitro*; only life can manufacture pepsin from blood and an acid from alkaline or neutral salts, and separate these without digesting the wall of the stomach in the very act itself. It is most unfortunate that anything to do with a machine should be mentioned in this connexion.

Because the stomach "works" rhythmically and predictably we may call it a machine for turning out pepsin from blood and liken it to a machine for turning out (say) newspapers, but the secretion of pepsin is not mechanical, nor is the output of newspapers vital. Processes that closely resemble each other are not necessarily identical. In a decerebrated animal the same predictable reflex action can be obtained time after time from the same stimulus, and we may speak of the inevitableness of the mechanism of reflex arcs; but in no other sense is the spinal cord a machine.

Non-vitalistic physiologists are blamed not merely for speaking of organs and organisms as machines but

also for daring to study organs and systems by themselves, whereby, it is alleged, they have lost sight of the wonderfully co-ordinated activities of the animal as a whole.

It would seem that the physiologists can never do anything right; at a time when nothing was known of the heart, or of the liver, or of the retina, what else could the investigator do than confine his attention to one thing at a time? Some of us, indeed, are trying to take a comprehensive synthetic outlook over the whole field of vitality, but that could not have been done by the pioneers, who could only push their way slowly into an unknown territory.

One would infer from the obituary notice of the late Sir James Mackenzie in the *Times* (January 27) that physiology is bankrupt. Sir James is quoted as having said: "When this [his own view of physiology] is realised, the whole of the physiological interpretation of the functional activities of organs will have to be scrapped. This is one of the results that I anticipate."

The physiological methods by which were discovered the localisation of cerebral function, reciprocal innervation, the endocrine function of the adrenals, the thyroid gland, and the pituitary, by which insulin was isolated and adrenalin synthesised, cannot be discredited.

The experimental work of Schafer, Bayliss, Starling, Sherrington, Pavlov, MacLeod, and the Hills is not only not to be scrapped, but is also to be recognised as the logical modern basis of practical medicine. The researches that led up to electrocardiography, with which Sir James Mackenzie himself was so conspicuously associated, are another illustration. From some of his expressions the incautious reader might suppose that current physiology was useless as an introduction to medicine, and that the secret of success in diagnosis and treatment consisted in the reinstating of a "vital force." Mackenzie, writing in the *British Medical Journal* (March 1, 1924), thus expressed himself: "The reason for the lack of progress in respect of [knowledge of] living matter has been the absence of a knowledge of a vital force!" The whole tenor of this paper is that we must distrust the results of "artificial" stimulation of tissues because the effects of these are not normal, are not the same as those produced by the "vital force." The experimenter, in fact, comes under a heavy condemnation. We are further told that because we do not better understand pain and why certain reflexes occur, this "vital force" must be postulated.

The term "impulse" plays a large part in this neo-physiology. We are told: "Where a cell discharges its energy in the shape of its peculiar [particular] function, it at the same time discharges an impulse." We must know, therefore, where in the conceptual scheme of things, which has served physiology so well for the last thirty years, we can place this all-important "impulse."

As regards protoplasm three concepts are fundamental—(a) its affectability (irritability), (b) the stimulus that may operate upon it, and (c) its own response. The behaviour of a living efferent nerve may best illustrate the relations between the members of this biologic trinity. The neuroplasm, in virtue of its possessing the property of responding to a stimulus (affectability), and having received a stimulus, responds

by giving rise to an excited state which travels down the nerve as the impulse to the effector organ at the periphery, say a muscle, which twitches when the impulse impinges on it.

Let us suppose that the stimulus is a blow on the nerve, or a pinching of it, seeing that the electric stimulus of the induction coil was regarded so unfavourably by Mackenzie. Of course the existence of this impulse is an inference from what happens: a nerve receives a blow at one end and a muscle twitches at the other; something must have passed down the nerve, and that something we have for a long time called the impulse. It is said to travel down the nerve by reason of the nerve possessing conductivity.

The other indication that something is passing along the nerve is that if a galvanometer be substituted for the muscle, then when a blow is given to the nerve, the galvanometer records the presence, for a very short time, of an electric disturbance in the nerve. We infer that this electric current is an outward and visible sign of the existence of the invisible nerve-impulse. But just here a very important conclusion is reached, namely, that the impulse in the nerve on arriving at the muscle is, for the muscle a stimulus to it to "contract"; the impulse in the living nerve can, then, an instant later, be the stimulus for the living muscle, the response of which is a state of shortening or contraction.

We infer that in the intact animal the nerves are conveying impulses normal or homologous, exactly similar to our laboratory ones, because if a nerve *in situ*, for example the phrenic, is connected to a galvanometer, electric currents in this case also are seen to pass through that instrument. These natural (normal) impulses must be the natural (normal) stimuli for the muscles *in situ*.

All this is very elementary; but it is evidently necessary to restate it because it accounts for everything that Mackenzie observed without calling in the aid of a "vital force" at all. We fail completely to see where and why this force needs to be invoked, and why physiology is bankrupt if it is not so introduced.

If this "vital force" is another name for the nerve-impulse—and it can scarcely be synonymous with either "stimulus" or "response"—then it is a superfluous term. If it is not a synonym for any of the three, then it is some fourth thing for which apparently there is no place in the scheme which has served biology so well in the past. The neo-physiologist may reply: it *is* a synonym for the nerve-impulse, but it comprehends "impulses" in all other tissues. Mackenzie's own words, in a paragraph headed, "The *impulse* a *vital force*," were: "An impulse is the product of cell-activity, it can only be conveyed by living structures and acts by stimulating cells to discharge their function . . . it differs from all other forces."

If the impulse in this passage be confined to nerve-impulse, no fault can be found with it, for the nerve-impulse is the product of (nerve) cell activity, it can be conveyed only by the living structures of the nerve, it acts by stimulating (muscle) cells to discharge their function (of shortening), and it differs from all other forces in that, as a nerve-impulse, it is *sui generis*. But why declare that unless we call this impulse

a "vital force," physiology is to be discredited ("scrapped").

We do not need an additional name for the nerve-impulse; if we are forced to give it a new name, why give it one so redolent of obscurantist animism (*loc. cit.*)?

It is, however, quite clear that by "impulse" Mackenzie meant something that was active in all the tissues, for he speaks of *cells* in the widest sense. Now what are these impulses in tissues other than neural? What impulses are there in muscle, connective tissue, gland, fat, bone? In muscle we have states of contraction; and we can call them "impulses" if that will rescue physiology from the scrap-heap, but one fails to see what is gained thereby. As for "impulses" in connective tissue, fat, or bone, we have no evidence of them. In glands, doubtless, some states of excitation can travel (slowly) along, but again we see no benefit from calling them "impulses."

It is difficult to see, therefore, why physiology is to be declared as proceeding on a totally wrong road. It may be frankly admitted that there is in physiology more than is dreamed of by the mechanistic philosophy. The laws of matter that has never lived have failed so far to account for certain facts, for example, about absorption both from intestine and bladder, and for certain facts about urinary secretion. It has been shown that living membranes act very differently from dead ones.

The materialistic view of life has failed signally to account for certain realities of our experience of which consciousness is the group name. Huxley himself made his bow to consciousness and waved it away as an epi-phenomenon. For the materialist, consciousness cannot be a cause of neural activity; nor can states of body affect mind, for mind is an illusion. The mechanistic theories are incapable of throwing any light on the central fact of experience, the permanence of personality amid the flux of matter.

Prof. Haldane has well said that "living" and "mind" are not reducible to simpler terms; they are the axioms of biology; and this thinker firmly believes that physiology is being retarded by mechanistic conceptions which deprive us of a complete view of life. As Prof. J. A. Thomson has said:<sup>1</sup> "We need new concepts such as that of the organism as a historic being which has traded with time." "We need these new concepts because there are new facts to describe, which we cannot analyse away into so-called simpler processes."

The most reasonable position to assume as regards vitalism is to insist that there is no compulsion for the biologist to be either a materialist or a vitalist. It is quite open to him to say that as he is dealing with an order of things that is unique, with existences that are *sui generis*, and that as his science is so young, he is not yet in a position to dogmatise and declare that *qua* life there are no categories beyond those the physicists and the chemists recognise.

Of all the many wise things Prof. Thomson said in his Gifford Lectures at St. Andrews (*loc. cit.* vol. 2, p. 147), this is surely one of the wisest: "We regard the question as one of the many *false dichotomies* with which man in his search for clearness has been led astray."

<sup>1</sup> "System of Animate Nature" (Williams and Norgate, vol. 2, p. 160).

### The German Museum of Science and Technology.

THE new building of the Deutsches Museum at Munich is to be opened on May 7, which is the seventieth birthday of its founder, Dr. Oscar von Miller. A short account of this great museum will therefore be of general interest.

In NATURE of September 17, 1908, there appeared an account of the conception and foundation of the Museum, with a description of the collections then housed provisionally in the old National Museum building in Maximilianstrasse. Only five years before this, Dr. Oscar von Miller had laid his plan for a great national science museum before a small circle of men of science, technologists, and representatives of the German Government and of the city of Munich. The idea was taken up with enthusiasm, and very fine collections were quickly brought together and arranged in the above building, which was opened to the public on November 13, 1906. On the same day the foundation stone of the permanent new building was laid by the German Emperor, the Prince Regent, and Prince Ludwig of Bavaria. The site for this building had been granted by the city of Munich, and on October 20, 1906, the design of the architect Prof. Gabriel von Seidl had been selected from the thirty-one competitive designs which had been submitted. This site, an island in the river Isar, is shown in Fig. 1.

The rapid increase in the number of acquisitions to the collections soon made it necessary to seek accommodation additional to that provided by the old National Museum. For this purpose the rooms of the

acquired, and to be on a scale sufficiently large to allow for ample expansion and development of the collections. The latter was to contain the collections of early and modern scientific and technical books, manuscripts, drawings, etc., as well as to provide workshops, laboratories, lecture-rooms, conference halls, etc.

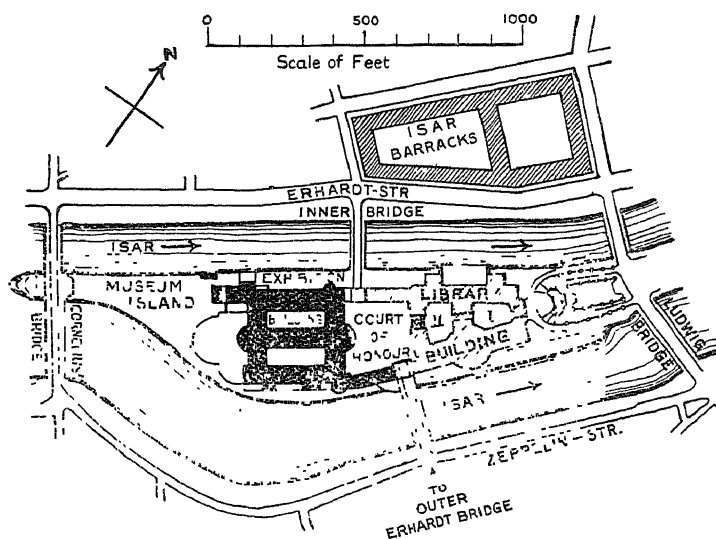


FIG. 1.—Sketch plan of the Deutsches Museum, Munich. The portion completed and occupied is blackened in. The old National Museum is less than half a mile to the north.

By the summer of 1914 the skeleton of the exhibition portion of the museum building had been completed, and it was then anticipated that the building would be open to the public by 1916. Building operations, however, were protracted by the War, but in spite of many difficulties, progress, though slow, has since been maintained steadily, and this portion of the Museum (shown in Fig. 2) is now ready to be opened. In September 1914, the old Isar barracks being required for war purposes, the collections therein had to be stored away. By September 1922 certain of the rooms in the old National Museum were closed, and the work of transferring the collections to the new building was commenced. On September 18, 1923, the whole of the old building was closed to allow of the systematic transference of the rest of the collections.

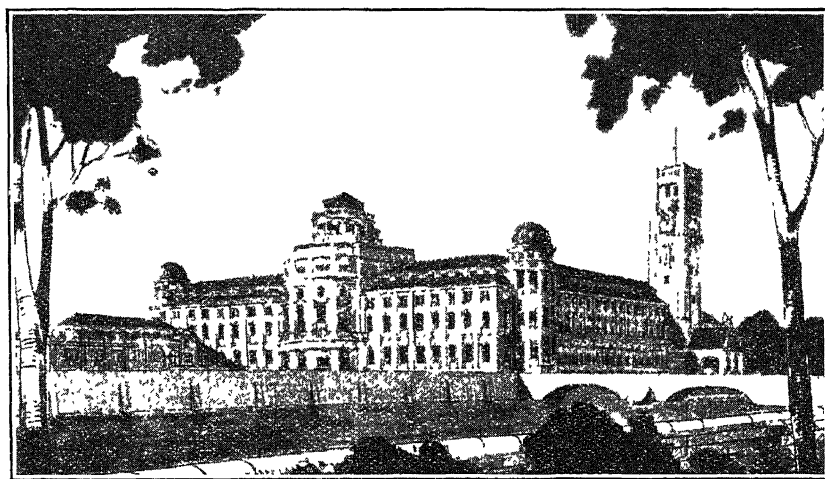


FIG. 2.—The Deutsches Museum, Munich. The exhibition building completed view looking south.

old dragoon barracks on the north-west bank of the Isar were utilised, and these were opened to the public on January 1, 1909.

The new building, in accordance with the scheme laid down by the museum directorate, was planned in two main groups, as shown in Fig. 1, namely, the Exhibition building, and the Library building. The former was to house the unique exhibits already

were referred to in NATURE in 1908. These features rested not only in the valuable exhibits themselves, but in the unique method of presentation, which aimed at giving the whole nation, student and layman alike, but particularly the young, an insight into and review of scientific and technical conceptions and inventions, with the human aspect carefully interwoven. The provision of this magnificent new Museum has allowed these

features to be developed in an enhanced degree, and the result is one of which the German nation may well feel proud.

With regard to the library building, the construction of which has still to be carried out, the original design of Prof. G. von Seidl was at an early stage found to be quite inadequate. The number of bequests and promises of books, drawings, plans, films, phonograms, etc., so exceeded original expectations that proper accommodation could be met only by a complete modification of the building programme. New plans were accordingly prepared by Prof. Emanuel von Seidl, who took over the work on the death of his brother. As indicated in the plan (Fig. 1), two long wings follow the lie of the land towards the north-east, where they are connected by a frontage facing a monu-

mental approach leading from the Ludwig bridge. These wings are further connected with each other by two transverse buildings. From the approach court a passage leads to Court I., another to Court II., and a third leads to a large impressive Court of Honour, on the opposite side of which is the chief entrance to the exhibition building. This Court is also directly accessible from both sides of the river by means of the Erhardt bridges. The library building will be provided with four floors above the ground-floor and basement, except in the two low wings by which it is connected to the exhibition building.

Amongst the many objects specially designed or acquired for the new building are the two giant planetaria, one of which was described in *NATURE* of December 27, 1924.

### Obituary.

DR. CARL ULRICH.

BY the death of Dr. Carl Ulrich on February 9, Austria has lost one of its foremost chemists, and radio-chemistry one of its pioneers.

After completing his course at the University, Dr. Ulrich was appointed assistant to Hofrat Lieben in the Chemical Institute of the University of Vienna. Later, he took up a post in the Auer works at Atzgersdorf, where, in conjunction with Dr. Haitinger, he made a study of the working up of pitchblende on a large scale. He was largely responsible for the organisation and equipment of the radium works at Joachimsthal in Bohemia, the management of which he took over in 1910. Here he laboured until the close of the War, when the radium works passed into the hands of the Czecho-Slovakian Government, and Dr. Ulrich, being of Austro-German nationality, had to resign his post. During the next few years he acted as adviser to the Ministry of Trade in Vienna, but was pensioned off two years ago. Since 1918 he had been engaged on radio-active work in the Vienna Radium Institute.

Dr. Ulrich always showed a keen and active interest in the work of the Radium Institute, and he was ever ready to give it the benefit of his ripe experience in the varied chemical problems that arose from time to time. Many of the tertiary radium standards to be found in various parts of the world are primarily the work of his hands, and they provide an appropriate memorial to his labours. He died of sarcoma of the lungs, which, in the opinion of his medical advisers, was a direct result of his long-continued manipulation of large quantities of radium. It is a significant fact, however, that Dr. Ulrich had not worked with radium in quantity since he left Joachimsthal in 1918.

Dr. Ulrich was keenly interested in the development of the science of isotopy, and some of the earliest work on the isotopes of lead and thorium was performed with material supplied or rendered accessible by his intervention. To the world of science in general, and to his Austrian colleagues and friends in particular, the death of Dr. Ulrich means a great loss.

ROBERT W. LAWSON.

THE death occurred on December 19 last of Prof. H. L. Wells, and we are indebted to the *American Journal of Science* for the following details of his life and scientific career. Horace Lemuel Wells was born on October 5, 1855, in New Britain, Connecticut, and went to Yale University in 1884 as instructor in analytical chemistry in the Sheffield Scientific School, and eventually was appointed professor of analytical chemistry and metallurgy. This post he held from 1893 until 1923, when he was made professor emeritus. Prof. Wells devoted much attention to the analysis of minerals; he determined the composition of a number of minerals from Branchville, described with E. S. Dana the new mineral beryllonite, and analysed a new platinum mineral which he called sperrylite. In 1891 he obtained a supply of the rare mineral pollucite from which a quantity of caesium salts, hitherto only known in small quantities, was extracted. This furnished material for a series of investigations on caesium compounds which covered more than thirty years. About one-half of his published work relates to these substances. Beginning with the perhalides of caesium, he investigated systematically the double salts of this element, and later discovered a series of triple salts, notably triple thiocyanates. In 1897 Prof. Wells translated Fresenius's "Qualitative Analysis," and he also published works on chemical calculations. In 1904 he became an associate-editor of the *American Journal of Science*. He was elected a member of the National Academy of Sciences in 1903.

WE regret to announce the following deaths:

Mr. S. R. O. Dudfield, hon. foreign secretary, Royal Statistical Society, past president of the Harveian Society, London, and for thirty years medical officer of health for Paddington, on April 19, aged sixty-four.

Sir Rickman John Godlee, Bart., K.C.V.O., hon. surgeon in ordinary to the King and a past president of the Royal College of Surgeons, on April 20, aged seventy-six.

Sir David Lionel Goldsmid-Stern-Salomons, Bart., vice-president and treasurer for many years of the Institution of Electrical Engineers, on April 19, aged seventy-three.

## Current Topics and Events.

SAMUEL F. B. MORSE, of Charlestown, Massachusetts, inventor of the Morse electro-magnetic recording telegraph, was born on April 27, 1791. He died a little more than half a century ago. That Faraday was born also in the same year is an interesting coincidence. The latter, lecturing at the Royal Institution in 1858, said: "Thoughts of an electric telegraph came over the minds of those who had been instructed in the nature of electricity, as soon as the conduction of that power through metals was known." Prof. Morse himself declared that he had "a distinct recollection of the manner, the place, and moment when the thought of making an electric wire the means of communicating intelligence came into my mind and was uttered." He was referring to the year 1832, and specially recalling an experience when a passenger on the *Sully*, a boat plying between Havre and New York. The construction and practicability of apparatus for the purpose in view occupied many anxious years. Morse held that such an invention would mark an era in human civilisation and contribute to the happiness of millions. For long he worked in penury. At last, in March 1843, Congress voted 30,000 dollars for definite experimental projects in connexion with the invention. In May, the following year, success in actual service was achieved. The message, "What hath God wrought," was sent from the Capitol at Washington to Baltimore, Morse operating the transmitter. It is of interest to add that at the Oxford meeting of the British Association in 1847, Sir Robert Inglis, the president, referred to the rapid progress of telegraphy in the United States as the immediate outcome of Morse's work, and alluded with regret to the circumstance that in England this great discovery had been, so far, inadequately adopted.

DR. HENRY FAIRFIELD OSBORN has issued his presidential summary of the work of the American Museum of Natural History during 1924 in advance of the main report. He entitles it "The American Museum and Education," and contrasts the education by means of this (or any properly organised) museum with that of the school and the university comparing it with that direct teaching through Nature which was the privilege of boys and girls in the Stone Age. That severe but inspiring approach to the duties and pleasures of life has been smothered under cities, lectures, books, and newspapers. Museum teaching should aim at restoring that immediate vision, and should regard "books and learning as the handmaids and not the masters of education." Dr. Osborn passes on to acknowledge the help received by the American Museum. Although a private institution, the museum manages to secure every possible aid from the United States government in its foreign relations. Consequently its expeditions meet with the cordial assistance of viceroys, governors, ministers, and government officials in the numerous foreign countries explored. Foreign sportsmen also, realising the value of the museum's work, readily place their skill and experience at its disposal. We are far from

grudging the help that is here so cordially acknowledged, but we should like to see more of the same assistance given by British governments to British expeditions.

GOVERNMENTS, no doubt, help those that help themselves. This it is that has been the merit of the American Museum of Natural History. Beginning with endowments and financial assistance from a few rich men, it now rests largely on the usual subscriptions of 7952 regular members. The average annual contribution from the City of New York amounts to little more than one-third of the whole. Would it not be possible for the Natural History Museum at South Kensington to obtain similar support? The National Art Collections Fund proves that even government institutions need, and can receive, private help. We in Great Britain need not be ashamed to follow the example of the American Museum of Natural History.

ON Friday, April 18, Dr. Fournier d'Albe gave a private demonstration of his television apparatus at his laboratory at Kingston-on-Thames. The apparatus shown represented a further stage in the simultaneous transmission of several elements of a picture by allocating different audio-frequencies to different elements. An image of the object to be transmitted was projected on a revolving siren disc provided with thirty concentric circles of holes. An image of the disc was, in turn, projected on a transmitting screen studded with thirty small selenium tablets, arranged so that each tablet was exposed to a different audio-frequency of intermittent light produced by the disc. The selenium tablets were connected in parallel with a two-valve amplifier, and the sound produced in a loud speaker at the receiving station was allowed to act upon thirty compound resonators, each of which responded to its own note when it occurred in the medley of sound transmitted. The response manifested itself by the appearance of a luminous patch on a ground-glass screen, reproducing an element of the original object both as to position and intensity. As the response occurs within a twentieth of a second, it is claimed that the apparatus transmits some six hundred signals per second. As, however, the complete transmission of an object such as a changing face requires at least ten thousand signals per second, there is still a considerable gap to be filled. Dr. Fournier d'Albe hopes to do this by increasing the number of resonators and their selectivity, or, in the last resort, by transmitting over more than one wire or on more than one radio-wave-length.

EXCAVATIONS at Ur during the final month of the season have brought to light a remarkable stele which Mr. C. L. Woolley, writing in the *Times* of April 15 and 16, regards as the most important monument yet found on the site. As an example of Sumerian art, it ranks with the famous Stele of the Vultures now in the Louvre. The reliefs on this stele among other subjects show Ur-Engur, the

founder of the Third Dynasty and the builder of the ziggurat, actually engaged in its construction. Two series of clay tablets have been found, one dating from 2200 B.C., the other from 2000 B.C., which give an intimate picture of the economic organisation of the temple with its establishment of ministers and court officials, additional to the priests, each in charge of a department—war, justice, lands, the household, the harem, etc. The tablets show in detail the receipts from tithes and rents or shares in the produce of the lands, while monthly balance sheets give the amounts received in kind from each farmer as well as the townsman, the latter paying in hides, gold, silver, copper, and other commodities. A strict account of the outgoings shows the rations issued to each of the numerous inmates of the temple and its precincts. These included a large number of women devotees who worked in factories, chiefly at weaving. The amount of wool thread issued to these and to the piece-workers, who occupied workshops outside the walls, is recorded with the quantity and quality of material it produced in each case. The food paid as wages was proportionate to work done, and children and old women received less than the young women. Temple officials when travelling held letters of credit which enabled them to obtain food in the cities through which they passed.

THE first of the series of lectures on "Illuminating Engineering," arranged under the auspices of the Illuminating Engineering Society at the Polytechnic, was given on Monday, April 20, when Mr. J. W. T. Walsh of the National Physical Laboratory delivered an address on "The Nature of Light and its Measurement." After a short introductory sketch of the development of the illuminating engineering movement, Mr. Walsh explained the chief terms used in dealing with illumination, processes in the photometric laboratory, and the use of portable illumination photometers, several examples of which were exhibited and examined after the lecture. There was a representative audience, including members of the staff of firms in the lighting industry and several of the lecturers responsible for subsequent items in the course. The organisation of a course of this nature, reviewing progress in various aspects of illumination, is a good idea which might be taken up by other educational institutions. It is particularly desirable that representatives of firms commercially concerned with illumination should have opportunities of hearing an impartial and scientific review of the problems with which they are concerned and of obtaining the latest information from specialists on various aspects of the subject.

In a lecture delivered before the Royal Institute of British Architects on April 20, Mr. P. J. Waldram discussed the natural and artificial lighting of buildings. Mr. Waldram reviewed problems involved in determining access of daylight into buildings, on which he is an expert, but artificial lighting was not dealt with in detail. The paper, however, dealt with several suggestive points, especially in connexion with comparisons between natural and artificial light.

Mr. Waldram apparently thinks that a considerably higher illumination is necessary for most processes in the case of artificial light than is necessary by daylight, but this view was disputed by several speakers in the course of the discussion. This seems to be a question on which further study is needed, and it is somewhat surprising that such a fundamental point should still be a matter of doubt. In view of the effect on the eye of an overhead sky of considerable brightness, and the presence of adjacent objects in general far brighter than those usually encountered by artificial light, one has the impression that the eye is accustomed to a range of illuminations by daylight much in excess of that afforded by artificial means.

In his presidential address to the Ipswich and District Natural History Society, Mr. J. Reid Moir, as reported in the *East Anglian Times* of April 2, surveyed the archaeology of Ipswich from Pliocene to Anglo-Saxon times. The evidence of the fossils of the Red Crag, indicating a gradual lowering of the temperature, together with the occurrence of striated flints and far travelled rocks in the underlying detritus bed, suggests that the crag was laid down in the first glacial period of East Anglia. The Cromer Forest Bed of Norfolk is not represented at Ipswich, but a series of gravels rest upon the Red Crag in which are implements, of Early Chellean Age in most cases, evidently derived from some older deposit. It is possible that this deposit was of Cromer Forest Bed age. The Tills and Contorted Drift of Norfolk overlying the Cromer Forest Bed are probably represented at Ipswich by the Kimmeridge Boulder Clay belonging to the second glacial period of East Anglia. The receding ice left hollows, often of considerable depth, such as the Foxhall Road Site, which contain in the brick earth and gravel filling hand axes of Acheulean and Mousterian types. The glacial deposits overlying the brick earths represented the third glacial epoch of East Anglia. The Upper Chelky Boulder Clay contains Mousterian implements torn from the brick earths by the ice. In a following period of climatic improvement, Upper Mousterian man inhabited the area, followed by Aurignacian man, whose occupation level was on the surface of a layer of stoneless loamy sand. This period was sealed in by a deposit of hill-wash, the result of a lowering of temperature, in which Solutrean implements had been found.

For several years past a Synonym Committee, working at first in connexion with the Ministry of Agriculture and later with the National Institute of Agricultural Botany at Cambridge, has been endeavouring to reduce the confusion which exists in respect of the names of potato varieties and their synonyms. The results of the investigations have been embodied in a pamphlet which includes information concerning varieties that have been definitely tested in regard to their susceptibility to wart disease. Most of the tests for immunity were carried out at Ormskirk, but some were conducted by the Scottish Board of Agriculture. Two years' freedom from wart is officially required to establish immunity, and the

list includes as immune only such varieties as have been unaffected by wart disease in at least two seasons' tests, though a single test is sufficient to brand a susceptible variety. Two lists are given, one of distinct varieties, in which case the immunity or otherwise is recorded, the other of synonyms, in which reference is made to the distinct variety of which the synonym is but another name. While acknowledging assistance received in the compilation of the lists, the Synonym Committee accepts full responsibility for the publication and for the inclusion or otherwise of any given name.

REFERRING TO OUR note (NATURE, April 11, p. 545) on Prof. R. Hamer's suggestion to name the undiscovered element of atomic number 43 "moseleyum," after H. G. J. Moseley, Prof. Irvine Masson writes that such action would not, as stated, be an innovation, as "one element is named after an individual: namely, Gadolinium, a rare-earth element, called after Gadolin." The historical facts appear to be as follows. The mineral gadolinite, discovered in 1788, was named after the Finnish chemist Johann Gadolin, who in 1794 discovered a new earth—yttria—in it. About a century later, Marignac showed that yttria (which he had obtained from samarskite) contained a new element, and when Lecoq de Boisbaudran announced to the Paris Academy of Sciences that Marignac had chosen for it the name "gadolinium," he gave no reason for the selection (*Comptes rendus*, 1886, p. 902). The case of the element samarium is somewhat similar. The complex parent mineral samarskite was, apparently, named after a Russian mine officer, Samarski. When the existence of the element was proved, Lecoq de Boisbaudran told the Academy that the honour of its discovery really belonged to several investigators, and he proposed the name "samarium" because the word was "derivé de la racine qui a déjà servi à former le mot 'samarskite'" (*Comptes rendus*, 1879, p. 214). Whether the words "gadolinium" and "samarium" were derived directly, or indirectly, from the names of men or minerals appears of little moment; both perpetuate the names of individuals, and therefore, in this sense, the appellation "moseleyum" would have two precedents.

A MEMORANDUM, addressed to the Council of the Industrial Institute, 102 Belgrave Road, London, S.W.1, has been issued suggesting an inquiry into "Balanced Industrial Development." The objects outlined include the promotion of scientific research and its organised application to industry, the strengthening of the foundation of industrial ethics, the formation of a clearing house for the collection and diffusion of information on all questions of industrial relations, and the examination of legislative and other proposals affecting industrial relations. The recently formed Industrial Institute is essentially non-political and it receives influential support from eminent representatives of both labour and capital, scientific and industrial bodies. It is hoped that the co-operation it affords will promote not only a better recognition of the value of science to industry, but the viewing of controversial questions in a more impartial and

scientific spirit. The memorandum suggests the appointment of a special committee of the Institute to investigate all such problems.

THE eighth of the public lectures on "Physics in Industry" being delivered under the auspices of the Institute of Physics will deal with "Physics in the Rubber Industry with special Reference to Tyre Manufacture." The lecture will be given by Dr. W. Makower in the rooms of the Royal Society, Burlington House, London, on Wednesday, April 29, at 5.30 P.M.

THE summer meeting of the Institution of Electrical Engineers will be held this year at Birmingham on June 9-12. As three hundred members and their ladies have already sent in their names, others wishing to take part are advised to send their applications without delay to the Secretary of the Institution, Savoy Place, Victoria Embankment, London, W.C.2.

THE Council of the Royal Statistical Society will, in 1925, again award the Frances Wood Memorial Prize value 30*l*. The prize will, as before, be awarded for the best investigation received not later than October 26, of any problem dealing with the economic or social conditions of the wage-earning classes, the subject to be treated on statistical lines. Particulars can be obtained from the honorary secretaries of the Royal Statistical Society, 9 Adelphi Terrace, W.C.2.

THE Coopers Hill War Memorial Prize, founded by members of the Royal Indian Engineering College, Coopers Hill, in commemoration of members of the College who fell during the War, is awarded annually by the Institution of Civil Engineers and triennially in turn by the Institution of Electrical Engineers, the School of Military Engineering, Chatham, and the School of Forestry, Oxford. The triennial award will be made this year by the Council of the Institution of Electrical Engineers for a paper on "The Applications of Electricity to Metalliferous Mining." Papers should reach the Secretary of the Institution not later than October 31.

A BILL has recently been passed by Congress, by which the United States Coast and Geodetic Survey is "authorised to make investigations and reports in seismology, including such investigations as have been heretofore performed by the Weather Bureau." In at first placing such work under the Bureau, the United States Government followed the example of other countries, for example, of Italy, where, since 1887, the system of earthquake stations has been under the control of the Central Meteorological Office. The advantage of the change in the United States is obvious, for the Coast and Geodetic Survey may at any time, as in 1906, be called on to measure the crustal deformations in the central district of a great earthquake.

THE highly successful conference held at Hoddesdon in September 1924, on Special Libraries and Information Bureaux, has resulted in financial support being obtained from the Carnegie United Kingdom Trustees for a period of two years in order to give the new movement an opportunity of becoming self-supporting.

Mr. G. W. Keeling has been appointed organising secretary to the committee which was formed during the conference to ensure the continued co-operation of the interests there represented. Active arrangements are being made for the holding of a second week-end conference at the end of September of this year, and for the preparation of a directory of special libraries and information bureaux for the United Kingdom.

THE gold medal of the Institution of Mining and Metallurgy has been awarded to Dr. Richard Pearce in recognition of his lifelong services in the advancement of metallurgical science and practice. Dr. Pearce was for many years engaged in metallurgical work in the United States, and since his return to England has been associated with the tin-smelting industry. The Council of the Institution has awarded "The Consolidated Gold Fields of South Africa" premium of forty guineas to Mr. Thomas Pryor, for his paper on "The Underground Geology of the Kolar Gold Field," and the "Arthur C. Claudet" and "William Frecheville" students prizes of ten guineas each to Mr. F. H. Edwards (Birmingham) and Mr. D. W. Bishopp, respectively.

THE National Academy of Sciences having approved the recommendation of the Committee on Award of

the Daniel Giraud Elliot Medal for 1924, the medal and honorarium will be presented at the April meeting of the Academy to Abbé Henri Breuil for his work, in collaboration with MM. Capitan and Peyrony, on the volume "Les Combarelles des Eyzies," as the most outstanding contribution of 1924 in this field. Henri Breuil is the foremost living authority on the archæology of the Old Stone Age. His chief contributions are the recognition of the great Aurignacian upper palæolithic stage and the monographing of the entire Stone Age art of France and Spain. He is a man of untiring endeavour, great personal courage, and deliberate and philosophic interpretative powers. He is the head of the Institut de Paléontologie Humaine, which was founded by the late Prince of Monaco. This is the eighth award of the Daniel Giraud Elliot Medal.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: junior assistants at the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (May 9); Superintendent of a Government Research Establishment in Lancashire—"S.U.," c/o Chas. Barker and Sons, Ltd., 31 Budge Row, E.C.4; a junior lecturer in science at the Royal Military Academy, Woolwich—The Under-Secretary of State, the War Office (S.D. 3), Whitehall, S.W.1 (May 30).

### Our Astronomical Column.

THE BRILLIANT FIREBALL OF EASTER SUNDAY.—Mr. W. F. Denning writes: On the evening of Easter Sunday, April 12, at 21<sup>h</sup> 40<sup>m</sup> G.M.T., a fireball of large size and dazzling brilliancy was seen by hundreds of observers in the south-west of England. A great number of descriptions have been received from spectators in Cornwall, Devon, Somerset, Pembroke, Glamorgan, and other places. According to most of the estimates, the fireball moved rather slowly and passed over the sea between Cornwall and Pembroke. It concluded its path when about twenty-five miles west-north-west of Strumble Head, near Fishguard. The fireball may have fallen into the sea when it had traversed another twenty-five miles, but it is doubtful if it survived, and no reports have come in that it was actually seen to fall.

The object was one of the most brilliant that has appeared in recent years. The illumination of the atmosphere and landscape which it occasioned just before its disappearance was remarkably vivid and startled many observers. Two or three minutes afterwards a deafening noise, like a double explosion, was heard at Fishguard, and at other places in the neighbourhood.

The nucleus of the fireball is described as emitting a steel-blue colour, and it left a broad train of fiery sparks in its wake, but this vanished immediately. During its visible course the object descended from about sixty-nine to twenty-two miles at a very moderate speed, and was directed from a radiant point in Virgo, but the exact position of this is not defined by the observations available at the present time.

COMETS.—The three comets (Schain, Reid, and Orkisz) have all been observed recently in England. The two latter are fairly bright, about magnitude seven, but Reid's is getting too low for easy observation here.

Mr. Orkisz discovered his comet at the small observatory on the summit of Mt. Lusina in Poland, a few miles south of Krakow. It is rapidly moving north and will soon become circumpolar.

Mr. G. Merton (B.A.A. circular No. 5) has computed the following orbit from a combination of ten observations extending from April 5 to 14:

T	1925 April 1.2904 G.M.T. (new)
$\omega$	35° 55' 17.3"
$\Omega$	318 1 25.3
$i$	99 57 22.6
log $q$	0.045126

#### EPHEMERIS FOR 0<sup>h</sup> G.M.T.

	R. A.	N. Decl.	log $r$ .	log $\Delta$ .
Apr. 25	22 <sup>h</sup> 51 <sup>m</sup> 35 <sup>s</sup>	40° 13'	0.070	0.180
May 3	23 7 31	51 5	0.087	0.170
" 11	23 31 53	62 2	0.108	0.172
" 19	0 17 14	72 17	0.130	0.185

In May the comet will be observable throughout the night.

Schain's comet is still a difficult object, of about magnitude eleven. It is receding from the earth, and this more than offsets its slow approach to the sun. Perihelion passage will probably be about August, and the perihelion distance promises to exceed that of any known comet, being apparently somewhat greater than that of the comet of 1729 (4.05 astronomical units) which has held the record until now. The orbit was an extremely difficult one to compute from the early observations, and the dates found for perihelion passage ranged from November 1924 to February 1926.

The following approximate ephemeris should suffice for finding the comet:

	R. A.	N. Decl.
Apr. 28	10 <sup>h</sup> 50 <sup>m</sup>	4° 3'
May 6	10 41	4 17
" 14	10 32	4 27

## Research Items.

**RACIAL PSYCHOLOGY IN THE UNITED STATES.**—The population problem and, in particular, the colour question in the United States, which has produced much dogmatic but unsubstantiated assertion, has had a beneficial effect in leading to an examination of records for exact data which may bear upon the question of mental racial differences. In the *Scientific Monthly* for March, Dr. Bertha M. Luckey of Cleveland, Ohio, a city which contains a large percentage of foreign-born adults, has analysed the results of tests of school children for intelligence. As the data were obtained from the clinic, the majority of the children were super- or subnormal. Figures are shown for ten nationalities. The highest percentage of subnormal children is shown by the Negro and Polish groups (65 per cent.), and the lowest by the Jewish (29 per cent.), the intermediate order being Slavish, Slovenian, Italian, Hungarian, German, Bohemian, and American (30 per cent.). The largest percentage of bright or unusually bright occurred among the Jewish (24 per cent.), the remaining groups being in the following order: American, German, Bohemian, Slovenian, Hungarian, Slavish, then Polish, and Negro, each 1 per cent., and Italian, 0.5 per cent. Yet in the class "imbecile" the Jewish and American groups had more than the Negro and Slovenian groups. Another paper in the same issue, by the Rev J. E. Gregg, compares the academic results of students admitted to the Hamilton Institute over a number of years, beginning in 1901. Seven grades of colour, ranging from black to "no trace of colour," have been recorded, but the scholastic results show little difference between the colour groups. Of the twenty-one best scholars of the graduating classes in eleven years (1914-24), the percentages are as follows. Dark brown, 28.5, brown, 28.5, light brown, 28.5, light, 14.2. Of the entrants in 1901-10, the three groups dark brown, brown, and light brown formed 82.3 per cent.

**THE COUSIN IN VEDIC RITUAL.**—In the *Indian Antiquary* for January, Mr. A. M. Hocart has an interesting suggestion to offer as to the interpretation of the word *Bhratryya*, which occurs in a formula indicating that the Vedic sacrifice was a victory over evil powers opposed to the sacrificer. The formula is translated "slaying his wicked spiteful enemy." The word *Bhratryya*, "enemy," is doubtful, but appears to indicate relationship, possibly "cousin." It is suggested that it may bear the meaning more specifically of mother's brother's son, *i.e.* cross cousin. It would then be a case of the ceremonial hostility of cross cousins. There is no direct evidence which supports the suggested meaning of the word; but it is possible that the Vedic relationship system was classificatory and would therefore as elsewhere give rise to cross-cousin hostility. Further, from both Fiji and South Africa there is evidence that the cross cousin in the cases of ceremonial hostility is a representative of the gods. The hostility is not real or infused with hatred. The cross cousin may be identified with the demons through some conception such as is indicated in the story that Namuci, the demon, stole Indra's vigour, the essence of his food. The cross cousin may therefore eat the sacrifice, or part of it, taking upon himself the evil and acting as scape-goat; as such he is reviled and despised, and in Fiji and South Africa, driven away.

**POLYEMBRYONY IN PLATYGASTER.**—The remarkable phenomenon of polyembryony is now known to be a constant feature in the development of certain minute

species of parasitic Hymenoptera. In the *Journal of Agricultural Research*, vol. 28, No. 8, 1924, Messrs. R. W. Leiby and C. C. Hill describe the polyembryonic development of *Platygaster vernalis* in the larva of the Hessian fly. The egg of the *Platygaster* is so placed in the egg of the Hessian fly that it is eventually found in the mid-intestine of the host embryo or young larva, with unfailing regularity. Each egg of the parasite gives rise to about eight embryos, all of which it is believed are of the same sex. In the course of maturation two polar bodies are formed, which become the original paranuclear masses, while the cleavage nucleus becomes the progenitor of the embryos. The latter are surrounded by a membrane, or trophamnion, which is formed from the paranuclear masses, and when the larvæ are ready to issue, they rupture the trophamnion, thus becoming liberated into the host's intestine. The larvæ eventually consume the whole of the contents of the Hessian fly larva, leaving only the cuticula. Each parasite constructs a cocoon within which it transforms into a pupa and later into an imago. Although the parasites which issue from one host are usually of the same sex, it is believed that the occasional mixed broods that are met with originate from a fertilised and an unfertilised egg deposited in the same individual egg of the host.

**PLEISTOCENE FOSSILS FROM SAN PEDRO, CALIFORNIA.**—From a cutting through Nob Hill, at San Pedro, California, exposing beds of the Lower San Pedro Series of the Pleistocene, Mr. T. S. Oldroyd obtained from the deposit some 242 species of Mollusca (*Proc. U.S. Nat. Mus.*, 65, art. 22). At the close of this period when the climate of California began to get warmer, the majority of these molluscs migrated north, some 115 being found to-day in Puget Sound; or they sought the cold waters of a greater depth, for there seems to be a trail of the northern molluscs in about 100 fath. all along the coast as far as Lower California; whilst a few accustomed themselves to the change and are found living now near San Pedro. With the exception of two land and two freshwater snails, doubtless washed down into the deposit, the mollusca are all marine, and the author is able to append to his list the descriptions and figures of 20 new species and two new subspecies, mostly small forms. Some crab remains were identified by Miss Rathbun, and the list of these and a few other invertebrates is included in the paper.

**ICE IN THE ARCTIC SEAS IN 1924.**—The annual report of the Danish Meteorological Institute (Isforholdene i de Arktiske Have, 1924) is fuller than usual, especially as regards the Kara and Barents Seas and the east coast of Greenland, but, owing to lack of information, is very meagre concerning the Beaufort Sea and coasts of eastern Siberia. In European Arctic regions the year on the whole was marked by less ice than is the rule during spring and summer. In August and September the Kara Sea was exceptionally free from ice. The White Sea was clear in June and in the autumn froze much later than usual. In the north-eastern part of the Barents Sea there was more open water than usual; in August, the only month for which there are data, it came very near to Franz Josef Land. During April and May very heavy pack extended to the south-west of Spitsbergen so far south as Bear Island, but the northern part of the west coast, as usual, was clear. In June conditions changed completely, resulting in a summer with exceptionally little ice

in Spitsbergen waters. A Norwegian sloop circum-navigated North-East Land during August. On the east coast of Greenland the few observations suggest a narrower belt of close pack-ice than usual. Iceland was touched by pack-ice only during February. The Newfoundland Banks had little ice and few icebergs, and Davis Strait was fairly clear. The report is illustrated with several maps.

**ISOSTASY AND GEOLOGY.**—A valuable paper on "The Geological Implications of the Doctrine of Isostasy," by A. C. Lawson, appears as Bulletin No. 46 of the National Research Council (Washington, June 1924). It is pointed out that in considering the transfer of matter from one portion of the earth's surface to another, it is often necessary to recognise that the newly loaded area may be widely separated from the source of the load. In such a case the loaded region and the surrounding territory cannot be balanced with the rest of the earth's crust by merely local flow; a general plastic deformation of the geoid then appears to be necessary to establish isostatic equilibrium. Continental glaciers, epicontinental seas, and large deltas are discussed as examples in which local deep-seated compensation fails to restore a world-wide balance. In the case of plateau lavas, it is not clear to what extent there is a real transfer in the horizontal as opposed to the vertical sense. Mountain ranges are considered both with and without a downward protuberance, and the discussion clearly supports the view that ranges are supported by flotation due to a downward concentration of lighter rock immersed in heavier rock. It is suggested that oceanic deeps may be due to a stretching and thinning of the lighter upper part of the crust accompanied by an upward sag of the heavier sub-crustal matter. The process recalls the mechanism of Wegener's displacement hypothesis, and like it involves great tensional stresses due to the flowing of the crust down a low gradient. As Lambert and Jeffreys have independently shown, no adequate cause for such a process can be imagined in harmony with our observational knowledge of the strength of known rocks.

**NATURAL GAS IN ALBERTA.**—The Canadian natural gas industry is second only to that of the United States, the annual production in the former country amounting to some 20,000,000,000 cubic feet, valued at five million dollars. The bulk of this gas comes from the provinces of Alberta and Ontario, but there are already signs of exhaustion in the eastern fields, and steps are being taken to conserve the remaining resources and to regulate the supply. In Alberta the position is different, since several large flows have recently been struck, and there are also many potentially favourable areas which have not been explored. Much of the Alberta natural gas is apparently a dry gas, so that gasoline extraction has not on the whole assumed the importance in the Canadian gas industry that it has done in the United States; one area, however, that of Turner Valley, yields a wet gas capable of giving from 0.2 to 0.7 gallons of gasoline per 1000 cubic feet of gas, which compares favourably with some of the results achieved in the Mid-Continent region of America, the gasoline-yielding gas shows on analysis, as might be expected, a much higher proportion of ethane than the dry gas, with a corresponding decrease in the nitrogen content, a point of importance in connexion with helium recovery. It seems unthinkable that helium should be allowed to go to waste in view of its enormous value for aircraft purposes, but such is largely the case in Canada at the present time. Mr. R. T.

Elworthy, in his report on the "Natural Gas in Alberta," (Canada, Department of Mines, 1924 for 1923), states that from two fields, Bow Island and Foremost, some ten to fifteen million cubic feet of helium per year might be obtained at a cost of between 50 to 100 dollars per thousand cubic feet, if an efficient process were developed to treat low helium-bearing gases. He rightly points out that no private corporation can be expected to experiment on these lines; the work or research necessary well warrants State enterprise and, we may add, an Imperial backing. There is also a possibility of establishing a carbon black industry in Alberta, and the author thinks that a ready market could be found for this product providing it were sold at competitive prices with those current in Louisiana, the home of that industry.

**DEPTH OF SEISMIC FOCI.**—An important paper on this subject by Dr. S. K. Banerji, director of the Bombay and Alibag observatories, is published in the *Phil. Mag.* (vol. 49, pp. 65-80). The method adopted is to estimate the effects of the depth of the focus on the amplitudes of the different phases of the seismogram, assuming that the corresponding waves have the same amplitude at unit distance from the source. Taking the earth to be an infinite solid bounded by a plane, it is shown that, while the effect of the depth of the focus on the amplitudes of the primary and secondary waves at great epicentral distances is almost negligible, the amplitudes of the long-wave phase undergo a rapid decrease with increasing depth of focus. If the depth were so great as 1000 km., the amplitude of the primary and secondary waves at the antipodes should be about  $2.7 \times 10^{37}$  times as great as that of the long waves. If the depth were 200 km., the amplitude of the former would be about 400 times as great as that of the latter. If it were 100 km., the amplitude of the long waves would be about 55 times as great as that of the primary or secondary waves. Roughly speaking, therefore, about 100 km. or less is a possible depth for the seismic focus, while a depth of from 200 to 1000 km. is probably much too great. Taking the earth to be a spherical body, it is found that the depth is probably less than 100 km.

**SPECTRAL FREQUENCIES IN THE REGION BETWEEN LIGHT AND X-RAYS.**—Two papers are contributed by M. F. Holweck to the *C.R. Acad. Sci.*, Paris, of January 26 and March 2, in which a method of investigation is described, using very soft X-rays produced by bombarding a molybdenum anticathode with slow electrons, the velocity of which corresponds to a small potential difference  $V$ . Only the electrons from the first atomic levels are expelled, and the X-radiation forms a continuous spectrum without characteristic lines. The radiation is filtered through several sheets of celluloid, which has no discontinuity of absorption in the region investigated. The ionisation produced in argon and hydrogen chloride, sulphide phosphide, and silicide has been examined, the ionisation current being observed for different values of  $V$ , so as to obtain the curves showing the relation  $i = f(V)$  for the different gases. These have singular points at the critical potentials, and the following values have been found for Bohr's  $L$  III,  $L$  II levels, including a determination for aluminium by another method:

Ar	Cl	S	P	Si	Al
$246.5 \pm 1$	$203 \pm 1$	$163 \pm 1$	$128 \pm 2$	$98 \pm 2$	$68 \pm 2$

These figures are compared with those of other observers, and are found to lie well on a Moseley

diagram. The figure for argon, after certain small corrections, gives for the wave-length  $50.1 \pm 0.2$  Å.U.

**QUANTITATIVE ANALYSIS WITH THE X-RAY SPECTROSCOPE.**—Messrs. R. Glocker and W. Frohnmeyer show, in the *Annalen der Physik* for February, that analysis by means of the bright line X-ray spectra of the elements does not always give satisfactory results, and they suggest a number of reasons for this. They have developed a method in which the intensities in the absorption X-ray spectrum are measured, the substance to be investigated being placed between the crystal of the spectrometer and the photographic plate in the form of fine powder, a solution, a metal foil, or a plate. Measurements of the intensity are made photometrically on the record, just outside and just inside the absorption band of the element dealt with; if  $\lambda_A$  is the wave-length at the band head,  $I_1$  the intensity for  $\lambda > \lambda_A$ ,  $I_2$  the intensity for  $\lambda < \lambda_A$ ,  $p$  the mass of the element in the path of the rays in grams per sq. cm., and  $c$  a characteristic constant for the element,  $I_2/I_1 = I^{-cp}$ . The characteristic constants have been determined for elements with atomic numbers from 42 to 90 for the  $K$  absorption band, and from 90 to 92 for the  $L_1$  absorption band. The effect of mixing other substances with the element to be determined has also been investigated. The jump at the band head of an element is smaller when the absorption due to impurities increases. If two elements with high and low atomic numbers are mixed the amount of the first can be determined with an accuracy of about  $\pm 5$  per cent. Examples are given of the use of the method in determining the amount of barium in glass, of hafnium in minerals, and of the constituents of mixtures of salts.

**COLOUR PHOTOGRAPHY.**—The "Jos-Pe" process of natural colour photography on paper is described in the April colour supplement of the *British Journal of Photography*. The usual three negatives are made, and from these, prints are obtained by projection of any required size on plates coated with a gelatin-bromide emulsion containing very little of the silver salt. The exposure of these plates is made through the glass, and they are developed in a pyrocatechin developer which contains no sulphite and has the property of locally hardening the gelatin in proportion to the amount of silver reduced. After fixing, the unhardened gelatin is dissolved away in hot water, and there results a gelatin relief image slightly darkened by the reduced silver. To prepare a print, each plate is soaked in its proper dye solution, rinsed to remove the dye solution from the surface, and the gelatin coated transfer-paper is squeezed into contact with it. In a few minutes the transfer-paper has absorbed sufficient dye, and it is removed and squeezed in turn on to the other two plates. The images on the printing-plates are so transparent that the registration offers no difficulty. If necessary a second application on either of the printing-plates may be made, and local corrections may be made by applying more colour with a brush.

**BERTHELOT'S BOMB.**—In a communication to the *Comptes rendus* of the Paris Academy of Sciences of February 23, Prof. C. Moureu describes the destruction of the original bomb calorimeter of Berthelot. This historic instrument was being used during the War in experiments with reactions of an explosive nature and burst on December 16, 1918, fortunately without causing any personal injury, although Prof. Moureu mentions that some minutes earlier he had the bomb in his hands. The head of the bomb lodged in the ceiling of the laboratory, 16 feet above the working

bench. This bomb had been in use for 30 years for the determination of heats of combustion, and, in spite of this long period of hard wear, was in perfect condition when it burst. The question of its replacement was a difficult one on account of the present price of platinum. The original Berthelot bomb contained about 1300 grams of platinum, and at the time the instrument was built, this cost less than the same weight of gold. The present price renders an exact reproduction impossible, and in collaboration with M. P. Landrieu, a new design of bomb has been worked out. The complete inner lining of platinum has been retained, but the amount required has been reduced to 128 grams, partly by changing the form from a cylinder to a bottle with large neck, and partly by the use of a laminated sheet of platinum (0.2 mm.), gold (0.4 mm.), and copper (0.4 mm.), the whole being worked as one sheet. The new pattern instrument has been at work in the laboratory of the Collège de France, and has proved satisfactory. At the same time other changes have been made with the view of reducing the magnitude of the cooling constant, and calorimetric determinations can now be carried out with an accuracy of 1 in 1000.

**CONSUMPTION OF POWER IN COAL MINING.**—The University of Illinois has recently published a Bulletin (No. 144) entitled "Power Studies in Illinois Coal Mining," by Prof. A. J. Hoskin and T. Fraser, which consists of a careful study of the manner in which power is utilised in the various operations of coal mining in the State of Illinois. As in all other countries, these collieries have of late years been resorting more and more to mechanical means of performing the various operations, and this has mainly made itself evident in an increased employment of electrical power. Here, as elsewhere, colliery companies commenced by themselves generating the power which they needed in their mines, but of late years there has been an increasing tendency towards purchasing current from the electric supply companies, or, as the Americans call them, "utility companies," and it is pointed out that in some cases such companies are in a position to supply current at a lower cost than that at which the colliery companies themselves can generate it. The net result of the increased use of power has been to diminish costs, but "some of the improvements have lowered costs of coal production per ton by merely increasing production rates, whilst other mechanical innovations have lessened costs by minimising labour." In order to determine the distribution of power consumption in the collieries, data were obtained from 50 representative mines, ranging from the smallest to the largest, from a daily output of 650 tons up to one of 5200 tons. Excluding manual or animal power, it would appear that steam performs 42 per cent. of the mechanical duties about these mines, and that 58 per cent. of the energy employed is electric. The average distribution of energy in all these coal mines is classified as follows: Hoisting, 17.2 per cent.; ventilation, 22.2 per cent.; pumping, 5 per cent.; mining, 22.1 per cent.; haulage, 23 per cent.; miscellaneous, 10.5 per cent. Quite naturally, however, these averages vary between exceedingly wide limits: thus the percentage of the total energy consumption used for hoisting ranges from 1.4 per cent. to 50.8 per cent.; for ventilation, from 2.2 per cent. to 55.9 per cent.; for pumping, from 0.1 per cent. to 35.9 per cent.; for mining, from 0 (where all the coal is cut by hand) to 45.7 per cent.; for haulage, from 0 (where only mule haulage is employed) up to 51 per cent.; whilst miscellaneous services absorb from 3.6 per cent. to 23.9 per cent.

## The International Geographical Congress.

THE International Geographical Congress, under the auspices of the Union Géographique Internationale, met at Alexandria and Cairo on March 28-April 9. One noticed well-known scientific men from France, Italy, Switzerland, Spain, Holland, Belgium, Poland, Yugoslavia, Greece, etc., as well as from England and Egypt. The deputations from Italy and from Poland seemed specially strong, while the French delegation included many leading members of the professoriate. The British-group included Sir Francis Younghusband, who acted as its chief; Sir Charles Close, the honorary secretary of the Union Géographique Internationale; Maj.-Gen. Lord Edward Gleichen, Col. H. G. Lyons, Admiral Sir John Parry, Lieut.-Col. Craster, Dr. Newbigin, Profs. Roxby and Fleure, and Mr. W. W. Jervis.

The Congress owed its preliminary organisation to the Société Royale Géographique de l'Égypte, the secretary of which, M. Cattauui Bey, worked very hard throughout for the success of the meeting. H.M. King Fuad honoured the Congress, in which he has taken great interest, with his presence at its opening session, and also received the members of the Congress on the first evening at the Royal Palace.

The scientific work of the Congress was organised in five sections, which met in the mornings and heard a number of papers, some of which were followed by valuable discussions. A few special addresses were given to the Congress as a whole, at sessions at which General Vacchelli, president of the Union Géographique Internationale, took the chair.

Lieut.-Col. Craster, on behalf of Major M'Leod, pleaded for reconsideration of the organisation, which is trying to promote the 1 in a 1,000,000 map scheme. That organisation is imperfect in the matter of co-operation between adjacent countries for common sheets, of placing sheets on sale in the world's great cities, and of financial support for the central bureau, which has suffered greatly through the vagaries of the international exchange markets. It is also felt that the regulations as to style of maps as laid down by a Conference at Paris have not proved satisfactory, and that different countries have executed the maps too differently. It was resolved to place the whole matter on the agenda for the next International Geographical Congress, to be held in England in 1928, and in the meantime to circularise all the nations concerned, in the hope of approximating to a common opinion.

M. de la Roncière gave an interesting summary of his well-known researches into discoveries in Africa in the Middle Ages, and showed how much was known and how much trade existed between oasis cities, for example, and the Italian republics. M. de la Roncière also exhibited a map found by him, which he showed reason to believe was a map contemporary with, and utilised by, Christopher Columbus.

Sir Francis Younghusband pleaded for better descriptive work in geography, urging that geographical writers should try to penetrate to the soul of the country they described, and should do this by learning to love the earth, as all great artists love the subjects at which they work. Prof. Collet gave a valuable paper from an English lady student in his laboratory, working under his direction. It showed how it was possible to obtain accurate photomicrographs of the layers of sediment on the floor of the Lake of Geneva. Slides were shown which made clear the succession of winter and summer layers, and allowed accurate estimation of their thicknesses.

Profs. Czckanowski and Stolyhwo brought forward methods of anthropological analyses and mapping,

and a discussion followed, in which Prof. Biasutti and others took part. Father Bovier Lapierro gave a most valuable account of years of research concerning prehistoric Egypt. He has found numerous stations of various ages, within the Palæolithic epoch, especially around the Mokattam region, and it is greatly to be hoped that his work may be published *in extenso*. It raises many important points in various branches of study. The same worker further roused great interest by announcing a quite recent discovery of small but dolmen-like stone monuments in the eastern desert. This announcement was considered so important that a few members of the Congress adventured out with M. Bovier Lapierro to see these monuments. They need further examination, which the Rev. Father is undertaking, but there can be no doubt as to their interest; their age remains for the present a matter of speculation.

Prof. Arctowski presented contributions from his well-known researches in meteorology, some with special reference to attempts to ascertain periodicity of temperature variations for short periods. M. de Margerie, who presided over the section on physical geography, contributed to a plenary session of the Conference an eloquent and appropriate tribute to the work of the late Franz Schrader, emphasising Schrader's wonderful knowledge of the Pyrenees, and the great historical atlas which remains as one of the chief memorials of a lovable personality. M. Sadik Bey gave an interesting and valuable account of the geology of Sinai, and a number of other papers dealt with matters of Egyptian interest.

M. Demangeon opened a discussion on rural habitations and their distribution, in which he urged the need for re-examination of the work of Meitzen, and in the discussion which followed, Miss Lefevre, MM. Marinelli, Michotte, and others took part. Arrangements were made for publishing an account of the discussion in the *Geographische Zeitschrift*, and for organisation of further inquiry with the view of a discussion with illustrative maps, at the 1928 Conference.

Though a visit to the famous Survey of Egypt was unfortunately omitted from the official programme, many members of the Congress arranged to spend some hours at this remarkable institution, which has created a huge map system that serves as the official property-registration for the whole of Egypt.

The Royal Geographical Society of Egypt had collected a large number of valuable large relief and geological and other models, which were much appreciated. The relief of the Aswan dam, geologically coloured, was specially eloquent.

On Friday April 3 was celebrated the jubilee of the Royal Geographical Society of Egypt, and the president of the Society gave a felicitous review of the Society's work in the great days of pioneering discovery. Representatives of the various nations offered their congratulations, those of the Royal Geographical Society of London being presented on behalf of the Society by Lord Edward Gleichen.

Naturally, visits to the unique Egyptian Museum, the Arab Museum and the mosques, the Coptic Museum and churches, the pyramids of Giza and of Saggara, the barrage of the Nile at the head of the delta, the observatory at Helwan, and many other places were made, and our Egyptian hosts showed the greatest generosity and kindness in this as in many other respects. Arrangements were made for visits, after the Congress, to Kharga oasis, Luxor, Aswan, Kosseir, and so on.

It was found that five sections gave the most practical distribution of the papers and the audience

at the Congress, and much experience was gained, which should prove useful for the Conference of 1928.

Before the meetings at Cairo, three days were spent at Alexandria, where the museum, the site of the ancient Canopus, and several other features were visited, chiefly under the enthusiastic guidance of Prof Breccia.

The overwhelming hospitality shown to the Congress will long remain as a vivid memory. Many

colleagues from various countries met for the first time, and were able to exchange opinions and thoughts on the many delightful excursions, notably on those on the Nile steamers. The warm sun and fresh breeze, the sunsets behind the pyramids, the minarets lighted for Ramadan, the citadel, and most of all the great river of history, form a picture which should make all who were present better geographers than they could be without a knowledge of the motherland of so much civilisation.

### The Preservation of Food.

[I]T is probable that few people realise the attention to detail which is necessary when articles of food have to travel long distances and yet reach the consumer in a condition which compares favourably with the appearance and character of the same food in the fresh state. Quite apart from the use of food preservatives, the storage of food at ordinary or low temperatures requires attention to a number of factors if success is to be obtained: to the investigation of these factors the Food Investigation Board has devoted a considerable amount of work, as revealed in its report for the year 1923<sup>1</sup>. The report commences with a short account of an expedition to Australia, which was sent out to investigate the cause of a disease of apples known as "brown heart," occurring during the transport of the fruit from that continent to Great Britain. Following a short section on the theory of freezing, come the reports of the six committees set up by the Board to deal with various aspects of the problems of food storage in relation to different types of food. The investigations have been carried on at various places, especially at the Low Temperature Research Station and the Biochemical Laboratory at Cambridge, at the Horticultural Research Station of the University of Bristol at Long Ashton, and in London, Manchester, and St. Andrews. About half of the report is occupied with an account of the investigations of the Fruit and Vegetables Committee, and this section can be conveniently considered together with the results obtained by the Australian Expedition.

It has been found that the following factors affect the keeping properties of stored apples: the soil and locality of the orchard, the age of the tree, the season and the presence of fungi on the fruit, the maturity of the fruit when gathered and its grading and packing; the temperature, humidity, and composition of the atmosphere of the storage chamber. The reports of the Expedition have been referred to in *NATURE* of February 7, p. 207, and April 18, p. 584. By regulating the temperature and composition of the air of the hold, the fruit can be kept in good condition; on the other hand, ventilation can be too efficient, since the removal of the carbon dioxide produced and the supplying of oxygen to replace that consumed hastens the process of ripening, which may thus be brought about before the fruit reaches the consumer. Hence the ventilation should be so arranged that the carbon-dioxide percentage is kept at about 10.

The problems of storing fruit in Great Britain have also been investigated: cold storage is usually superior to storage at room temperature, but in certain seasons this result may be reversed. Any deterioration which occurs in cold store is usually of a non-parasitic type and similar to that found in Australian apples in transport to Great Britain, whereas in ordinary storage the deterioration is produced by fungal disease. The species of fungi causing this deterioration have been investigated,

together with the path of invasion of the fruit: the spores appear to reach the fruit in the orchard itself, and to prevent this, improved orchard sanitation is necessary; once present, however, their development can be retarded by placing the fruit in cold store. The work of this Committee also includes a number of chemical investigations on the fruit kept in storage, such as carbon-dioxide production, and changes in sugar and pectin content and in acidity, all of which will throw light on the processes occurring in the fruit during ripening and storage.

Although foods of various kinds can be preserved well by freezing, it is not easy so to conduct the processes of freezing and thawing that the food is in an unchanged condition when it finally reaches the consumer. Thus, the yolk of frozen eggs may pass into a pasty state, the change being irreversible on thawing; this can be prevented either by never allowing the temperature to fall below  $-6^{\circ}\text{C}$ . or by freezing and thawing with great rapidity. The work of the Fish Preservation and Meat Committees has shown that irreversible changes may occur during the freezing and thawing of fish and meat, unless the freezing is carried out rapidly, as, for example, by immersion of the food material in cold brine, in this case the autolysis of the thawed food is similar to that of fresh meat or fish, whereas if the freezing is carried out in air, fluid separates from the tissues during freezing and drips away on thawing; in this fluid autolysis is rapid, but in the remaining tissues it appears to proceed at what may be called the normal rate. An attempt was made to preserve the fish more satisfactorily by exposing it to ice containing an antiseptic; although the latter hindered the development of bacteria, which still occurred at this low temperature, yet the method was unsatisfactory, since the tissues took up considerable amounts of the antiseptic.

The Oils and Fats Committee reports work on the series of glycerol methyl ethers, the glyceryl glucosides, the constitution of glycogen, and the synthesis of the higher aliphatic acids. The formation of fat by yeasts has also been investigated; the fat is formed from the carbohydrate of the nutrient medium in the presence of oxygen, and more fat is stored if phosphorus is also present in the medium; the phosphate is taken up by the cells in association with the carbohydrate, and it is possible that a hexosephosphate forms a stage in the conversion of carbohydrate into fat. This fat contains the growth vitamin A, which is probably synthesised directly by the yeast cells.

The Canned Food Committee has investigated the chemical changes occurring in fish during the processes of canning and storage. It was found that the presence of soluble tin facilitated the production of certain degradation products of the nature of volatile bases.

The report as a whole is a good illustration of the fact that there can be no dividing line between the two branches of research which are sometimes designated as "pure" and "applied" respectively.

<sup>1</sup> Department of Scientific and Industrial Research. Report of the Food Investigation Board for the year 1923. Pp. iv+77+4 plates+14 charts. (London: H.M. Stationery Office, 1924.) 3s. net.

### Navigation and Fishing on the Ganges.

THE first of Mr. Hornell's two memoirs<sup>1</sup> deals with the various navigation appliances employed on the Ganges. These are studied under two main groups, representing respectively the primitive and the advanced types. The former comprises rafts, dug-outs, skins, and other rudimentary forms adapted to simple requirements. Inflated buffalo-skins, used either singly as floats to support a swimmer, or by associating together two or more to give buoyancy to a platform-raft, are still in use locally on the Ganges, just as they are on the Tigris, as direct survivals from the ancient Babylonian and Assyrian days. It is curious that the skin-covered coracle, which also was used in ancient Mesopotamia, is not represented in this part of India; its absence being the more noteworthy since it is prevalent both in southern India and in the Trans-Himalayan regions (e.g. Tibet). On the Ganges its place seems to be taken by the *Tigari* of Eastern Bengal, a circular, round-bottomed pottery bowl, in which one man can sit and propel himself with a short paddle.

Of the dug-out canoes, the most peculiar are those made from the stem of the Palmyra-palm (Borassus). The base of the stem is much swollen, and the canoe, retaining the natural shape, is thickened and rounded at one end and narrow at the truncated other end, which is usually plugged with clay. These canoes are often used in pairs, lashed together to give stability. The type occurs also on the Colair Lake in Madras Presidency.

The difficulty and cost of obtaining large tree-trunks for making dug-outs is encouraging the increasing adoption of plank-built boats, of which Mr. Hornell describes several varieties, from the small, one-man *dinghi* to large barges and house-boats. The author points out that the Gangetic built-boat types do not link up with types seen farther east

(Burma, Siam, and China), but with western forms; and he urges the probability of a close link with the Mediterranean vessel-types. He suggests that these boat-designs may have been introduced by Dravidians who entered India through Baluchistan. He refers to the use of the *oculus* on some of the Gangetic vessels, and offers this as an important link with Egypt and the Mediterranean. In Fig. 14 the *oculus* is described as being situate upon the "stern-head" and this evident misprint for "stem-head" occurs more than once in the text.

This treatise is a useful adjunct to one published by Mr. Hornell in the same "Memoirs" in 1920 (7, pp. 139-256).

The second memoir is devoted to the fishing methods of the Ganges, dealt with under three environmental conditions—estuarine, riverine, and lacustrine. The first and last mainly involve shallow, still-water fishing; the second—by far the most important—is chiefly characterised by swift, deep waters. The various appliances are described in detail. Spearing fish with simple, many-pointed, or harpoon-headed spears, and also shooting them with bow and arrow, are still practised extensively. The art of trapping fish has been highly developed, great ingenuity being exhibited in designing and constructing the numerous varieties of traps. The same may be said of the netting-gear, which has been even more specialised into a great diversity of types adapted to different quarries and varied waters. Line-fishing, with or without a rod, is also popular, and much ingenuity is evinced in the practice of ground-baiting. The author has added an important item to the literature of fishing, which will prove of value when a long-wanted monograph is produced dealing with the primitive fishing methods of the world, their distribution and ethnological significance.

In both these memoirs the illustrations are very good and clear.

HENRY BALFOUR.

<sup>1</sup> "The Boats of the Ganges" and "The Fishing Methods of the Ganges," by J. Hornell. *Memoirs of the Asiatic Society of Bengal*, vol. 8, No. 3, 1924, pp. 171-238. Rupees 2 13

### Synthetic Methyl Alcohol.

THE first attempt to synthesise methyl alcohol by the catalytic reduction of carbon monoxide was apparently made by Sabatier and Senderens. These experiments were unsuccessful, but French research workers have persevered on the problem and the manufacture of methyl alcohol is now an accomplished fact. An accidental synthesis was carried out by the Badische Anilin- und Soda-Fabrik in 1913, during experiments carried out to investigate the possibilities of manufacturing liquid hydrocarbons by the catalytic reduction of carbon monoxide at high temperatures and pressures. No attempt was made, however, to pursue the investigation. In 1921 Calvert claimed to have obtained an 80 per cent yield of methyl alcohol by the action of hydrogen on water gas, and in the same year Patart, Inspecteur Général des Poudres, published his first patent. A small plant was erected at Asnières and Patart's method was successfully applied.

In Patart's process the gaseous mixture, containing two volumes of hydrogen to one of carbon monoxide, is compressed to 250-500 atmospheres and, after filtration, is passed over the electrically heated catalyst (400°). The gases are then cooled and the non-condensed portion re-circulated through the apparatus. A suitable catalyst is zinc oxide, it yields a greenish liquid containing a greenish precipitate of metallic copper from the apparatus. The liquid readily yields practically pure methyl alcohol on distillation with phosphoric acid, followed by a

redistillation of the first portion of the distillate. The final product has a somewhat disagreeable odour, but is perfectly free from aldehydes and ketones.

The great difficulty in working this process is to avoid side reactions. Above 300° and in the presence of certain catalysts (e.g. iron), carbon monoxide changes rapidly to the dioxide with deposition of carbon. The monoxide is also reduced to methane by hydrogen in the presence of nickel or iron. Conditions must be carefully adjusted to avoid these side reactions. Patart describes his process in some detail in the February issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, and discusses the prospects of its commercial adoption.

More recent work, using metallic suboxides as catalysts, has been carried out by Audibert. Higher oxides of nickel and of copper are reduced by the reaction mixture of carbon monoxide and hydrogen *in situ*, and Audibert found that with these catalysts temperature is the controlling factor. Between 225° C and some limit between 275° and 300° C, depending on the nature of the catalyst, methyl alcohol is the sole reduction product of carbon monoxide.

Patents were taken out in Germany in 1922 for a process very similar to Patart's, and a plant was erected at Merseburg in 1923 capable of turning out about twenty tons of alcohol per day. This synthetic alcohol is now being exported by Germany in considerable quantities.

## University and Educational Intelligence.

LONDON.—Prof. F. J. Cole will deliver on May 1 and 8 at King's College, at 5.30, free public lectures on "The History of Protozoology."

The following free public lectures at University College are announced: "The Physiology of Muscle and Nerve," Prof. A. V. Hill, on May 1, 8, 15, and 22, at 11, and "The Physical Environment of the Living Cell," Prof. A. V. Hill and Prof. J. C. Drummond, on May 4, 11, 18, 25, June 8, 15, and 22, at 5.30.

The latest date for the receipt of applications for grants from the Dixon Fund is May 14. Applications should be sent to the Academic Registrar, South Kensington.

THE Board of Education has issued a list (H.M. Stationery Office. Price 6d.) in which are conveniently brought together the numerous vacations courses to be held this summer in England and Wales. The courses are arranged alphabetically under four headings, according as they are being organised by the Board itself, by local educational authorities, by universities, or by other bodies. Among the subjects of the courses are psychology (Brighton), mining science (Amman Valley, Swansea, and Camborne), agricultural subjects (Nantwich), geography (Cambridge and Leeds), higher mathematics (Bangor), and zoology (Oxford).

THE Secretaries of the Royal Society will receive until June 1 applications for a Mackinnon Research Studentship, value 300*l.* per annum, tenable for two years with a possible extension, and for a Moseley Research Studentship of a like value and period. The first-named studentship is awarded to further natural and physical science, including geology and astronomy, and original research and investigation in pathology, the second is to further experimental research in pathology, physics, and chemistry or other branches of science, but not in pure mathematics, astronomy, or any branch of science aiming at describing, cataloguing, or systematising. The necessary application forms may be had from the Assistant Secretary of the Royal Society, Burlington House, Piccadilly, W.1.

THE second series of "Methods and Problems of Medical Education" has been issued by the Division of Medical Education, Rockefeller Foundation. It contains an introduction by Prof. Rosenau of the Harvard Medical School on the sanitary survey as an instrument of instruction in medical schools, and the reproduction (by photo-lithography) of the report of a sanitary survey of Rochester, New Hampshire, carried out and reported by Mr. Shields Warren while a third-year student in the Harvard Medical School. The survey is a model of what such a survey should be, and reflects great credit on the medical curriculum of the Harvard School. Nothing of the kind has been attempted in Great Britain, even in the curriculum for the future medical officer of health.

THE University College Committee of the University of London gives prominence in its report for the year ending February 28, 1925, to the need of additional funds for the equipment of the College laboratories for physical and electrical chemistry and engineering, for the new buildings for the Department of Zoology and Comparative Anatomy, and for additional museum cases and improvement of the animal houses in the Department of Applied Statistics. An

appendix to the report, showing the geographical distribution of students in 1923-24, gives the names of no less than fifty countries outside the United Kingdom. The total number of students from these countries was 518, including 90 from India, 43 from the United States, 36 from Japan, 35 from Switzerland, 29 from Australia, 27 from France, and 22 each from South Africa, Holland, and Russia. Among lecturers from abroad were 2 from Austria, 4 from the United States, 2 from Holland, 2 from France, and 1 each from Russia, Germany, Belgium, and Italy.

NATIONAL physical deterioration, as disclosed by Army recruiting officers' reports, formed the subject of a recent leading article in the *Times* (Educational Supplement), which concluded with the remark that although all parties are agreed as to the evil, little is being done towards remedying it, and the process continues. In the same issue appeared articles on the inadequacy of existing school buildings, on the excessive size of classes, on juvenile unemployment, and on the dangers involved in the schools turning out large numbers of young people who, having been educated without a thought of future work, cannot find work for which they are fitted. For all these problems a solution is offered by the Calcutta University Poverty Problem Study lecturer, Capt. J. W. Petavel, R.E. (retired), in his scheme for the organisation of educational labour colonies combining features of the Swiss labour colony and of trade and agricultural schools. Capt. Petavel, who has for some years conducted a polytechnic institute on lines intended to fit boys to work in co-operative organisations, obtained for his scheme the support of the late Vice-Chancellor of the University of Calcutta, Sir Asutosh Mookerjee, and many other prominent citizens of Calcutta, including the editor of *Capital*, who published a series of articles by him last January and February. These have been republished by *Capital* in pamphlet form together with a number of other papers on "Unemployment and the Calcutta University Propaganda for a solution by Educational Colonies, Home-crafting, and Home-crafting."

THE Board of Education issues from time to time valuable memoranda on the teaching of some school subject. These documents present the considered suggestions of the Board based on long observation in the schools and from the point of view of the educational discipline of future citizens. Such a memorandum would be welcomed by all teachers of geography, many of whom have been endeavouring for many years to find the best methods of teaching a necessary but admittedly difficult subject. The inquiries of the British Association Committee on Geography Teaching showed that remarkable unanimity prevailed among teachers as regards the purpose of geography, but extreme diversity marked the methods and practices of teaching. At the request of this Committee, the Council of the Association has expressed to the Board of Education the hope that a memorandum will be issued on the teaching of geography. There is of course no royal road in geography or any other subject, but it is an advantage to know what has been found expedient and useful. It is admitted that the home region must form the laboratory of direct geographical observation, but how should this laboratory be used? What geographically are fundamentals in the teaching of the British Isles, the British Empire, the world? What are the best methods of keeping one's knowledge of the world up-to-date? A memorandum would pool experiences and give form and coherence to the subject without stereotyping the teaching.

## Early Science at Oxford.

April 27, 1686. The Society gave Mr. Musgrave their thanks for ye care and paynes he has taken in executing the office of Secretary.

Dr. Bagley's letter of Nov. 26th. 1683, and Dr. Tyson's of December 6th, both concerning ye *Lumbricus latus* were read.

Dr. Smith communicated part of a letter from France, wherein some mention was made of young dogs recovered from drowning, by some salts.

Mr. Musgrave communicated a Discourse which he received from a freind of his concerning *Dyalling*: Mr Caswell was desired to give the Society some account of it the next meeting.

1687. Mr. President was pleased to communicate a Discourse concerning the Regulation of Easter, for 2000 years, and the moveable feasts according to the computation of the Church of England

Mr. Caswell gave an account of some bodys weighed hydrostatically, by weighing them in aer and water. 'Twas observd by him that the Calculus humanus is lighter in specie than any known sort of Stones.

April 28, 1685. A Letter from Mr. William Molyneux dated Dublin April 4 was read; in it was contained a Transcript of Sir William Petty's *Supellex Philosophica*, as it was presented to the Dublin Society, which also was read, and the thanks of ye Society ordered to be returned for it.

Mr. Aston communicated an account of ye Curiosities brought from Ceylon by Dr. Heerman, Professor of Botanic at Leyden.

A Letter from Dr. Pierce of Bath dated April 11 was read; it gave a farther relation of the Evets found alive in ye middle of a stone—Dr Cole of Worcester then described a case of Haemophoria, after which Mr. Bainbrig affirm'd, that ye little end of a Dutch Tobacco-pipe (ye piece about 2 inches in length) having been thrust into ye bladder by a Boy was cut out, and is now to be seen at Leyden.

A Letter from Mr. Aston was read containing a proposall of Dr Lister's of cutting for ye stone by entering ye Abdomen a little above ye Os Pubis, and opening the ffund of the bladder; on which account Mr. Bainbrig informed the Society, that one, Colbron, a Chirurgion at Haysham in Sussex, has taken out the stone of the bladder this way with successe. Mr. Bainbrig is desired by the Society to procure a full Relation of the particulars of this Operation; and Mr. Pigot is desired to try ye Experiment on a Dog.

April 29, 1684. Mr. President, takeing ye chair, gave order for ye reading of a letter dated April 24, from Mr. Aston; which affirmed, that ye experiment of makeing Plaister of Paris perspicuous, by striking turpentine thro it, was tried, and succeeded, before ye Royall Society. The substance mentiond in ye Minutes of Aprill ye 15th, and somtimes supposd to be a petrified heel of a shooe, breaking when bor'd; ye peices of it were produced, and judged to have been *allwais* stone: This gave occasion to some discourse, concerning such stones as are of a shape resembling some other body in nature, and are not found in beds, of which sort ye stone now mentiond is an example; and Dr. Plott acquainted ye Society, that he found a stone in Staffordshire in form like ye *heart* of a pullet; haveing lines in it, answering to ye coronary vessells of that muscle.

A Letter from Dr. Huntingdon to Dr. Plott, concerning ye porphyry pillars in *Ægypt*, was read: in it were enclosed ye draughts of two Pillars taken in that place. This letter being written at ye request of this Society, it was order'd that our thanks should be returnd to Dr. Huntingdon for this obligation.

## Societies and Academies.

LONDON.

Geological Society, March 11.—O. T. Jones: The geology of the Llandovery district (Carmarthenshire). The district lies east of the town of Llandovery, and extends for about 10 miles from north-east to south-west. It is divisible into a northern area and a southern area. In each area the succession is fairly complete, but in between them it is greatly attenuated. In proceeding from south to north, certain lithological changes have been noted in the Lower Llandovery. The fauna in the rocks appears in the main to have been drifted into the area from an adjoining tract, lying probably nearer to the shore-line. In addition to the differential subsidence and uplift along lines trending north-east and south-west, there is evidence of repeated elevation and depression along nearly east-and-west axes. The axes of these transverse movements appear to have persisted during the whole of the Llandovery epoch, but there is no evidence of them in the Wenlock rocks.—G. Andrew (1) The Llandovery and associated rocks of Garth (Breconshire). The Llandovery rocks lie north-west of Garth railway station, and extend from there in the direction of Newbridge. The Lower Llandovery rocks overlie the Bala with a sharp boundary, but with apparent conformity. The Middle Llandovery occurs in one small outcrop in the centre of the area, and is rapidly overstepped by the Upper Llandovery in both directions. The Upper Llandovery consists of two types, a lower comprising sandy mudstones with *Pentamerus oblongus*, etc., and an upper of pale mudstones ("Tarannon Pale Shales") (2) The relations between the Llandovery rocks of Llandovery and those of Garth. At Garth, as at Llandovery, the Lower and Middle Llandovery rocks are overstepped both north and south by Upper Llandovery or Wenlock deposits. At Garth they crop out in an elongated oval area; at Llandovery they form two roughly oval areas. The Middle Llandovery and the higher divisions of the Lower Llandovery are represented only in the central regions. These distributions are due to the fact that differential movements along nearly east-and-west axes (that is, transversely to the present strike) were in progress during the Llandovery epoch. The regions where the older Llandovery rocks are most complete were regions of persistent subsidence. The axes of elevation in both areas cross the present strike at practically regular intervals of about 5 miles, and the areas of subsidence are situated nearly midway between them.

Linnean Society, March 19.—S. Hirst: Species of mites of the family Trombiduidæ found on lizards. When more than one form occurs on the same host, a flattened form lives under the scales, and a rounded form between the toes or toe pads. In view of the considerable differences in the shape of the setæ, etc., these are regarded at present as distinct species.—Mrs Muriel Roach: A study of the physiology of certain soil algæ in pure culture. Although a very few species carried on the synthesis of organic substance from carbon-dioxide and water through the agency of sunlight, the great majority of those studied grew much better when supplied with an additional source of carbon, glucose being especially favourable to many species. A single species was selected for a more detailed investigation of the effect of different organic substances on its growth in liquid media. The alga was able to grow in complete darkness, given a suitable supply of food, at about half the rate that it grew in the same medium in the light. The logarithmic values of the bulk for the first nine

or ten days, in media completely favourable to the growth of the organism, lie on a straight line. The data indicate the importance of the compound interest law which evidently underlies the growth of the organism during the initial part of its growth. The theory of the auto-catalytic nature of growth does not appear to hold.—J. M. Brown: Some Collembola from Mesopotamia. Fifteen species of Collembola collected mainly in the neighbourhood of Bagdad and Amara, in Mesopotamia. Ten species and one variety are regarded as new. The Collembolan fauna of Mesopotamia shows much closer affinity with that of the Palearctic than with that of either the Oriental or the Ethiopian regions.

## CAMBRIDGE.

Philosophical Society, March 2.—H. Munro Fox: (1) Biology of the Suez Canal; (2) The effect of light on the vertical movement of aquatic organisms.—J. Brill. On a group having the Lorentz group for a sub-group.—A. W. Veater. On transvectant series.—E. V. Appleton and M. A. F. Barnett: A note on wireless signal strength measurements made during the solar eclipse of January 24, 1925. Measurements at Cambridge on short wave wireless signals from London have shown that the signal intensity exhibits variations which, though practically inappreciable during the day, become apparent about sunset and continue throughout the night. Typical sunset variations were found to be associated with the recent solar eclipse. The variations are attributed to interference between the direct ray along the ground and an indirect ray returned from the upper atmosphere. Such an indirect ray may be produced by ionic deviation without undue absorption if the mean free path of the effective ions is large, as suggested by Larmor. If the carriers are electrons, however, the action of the earth's magnetic field on the phase velocity of the radiation cannot be neglected. The possibility of a violation of the reciprocity relation between two wireless stations is thus suggested (v. also NATURE, March 7, p. 333).—H. W. Turnbull: A geometrical treatment of the correspondence between lines in three-fold space and points of a quadric in five-fold space.—J. B. S. Haldane: The origin of the potential differences between the interior and exterior of cells.—V. Nath: Spermatogenesis of *Lutobius forficatus*.—J. Gray. The mechanism of cell-division (II).—J. T. Saunders: The trichocysts of Paramoecium.

## EDINBURGH.

Royal Society, March 23.—Andrew Balfour: Reflections on malaria. Discussing the geographical distribution of malaria, special reference was made to the case of Scotland. Formerly malaria was prevalent in Scotland, but it has now declined. Anophelines still abound in Scotland, and it is quite possible that indigenous cases of malaria still occur. A combined mosquito and malaria survey might well be undertaken, if only from the scientific and academic point of view. In discussing malaria as a cause of death, emphasis was laid on the condition of liver failure which so often occurs. The value of the splenic index as a diagnostic method was considered, and its limitations defined. The introduction of stovarsol as a rival to quinine in the treatment of malaria and the nature of the malaria toxin were discussed.

## MANCHESTER.

Literary and Philosophical Society, February 17.—J. M. Gulland and R. Robinson: The constitution of codeine and thebaine. Experimental evidence was

adduced in favour of the assumption that dihydro-oxycodone contains the group  $\text{—CO—CH}_2\text{—}$ . Thebaine and codeine are now regarded as containing the groups  $\text{—C(OMe)=CH—CH=C—}$  and  $\text{—CH(OH)—CH=CH—}$  respectively, whilst the ethanamine chain  $\text{—CH}_2\cdot\text{CH}_2\text{—NMe—}$  connects positions 9 and 13 in the phenanthrene ring. The new formulæ are closely allied to the bridge formulæ previously suggested.

March 3.—A. Lapworth: (1) A comparison of some properties of cyanohydrins, carboxylic acids and phenols. The abnormalities of the  $\cdot\text{CO}_2\text{H}$  group are notorious. It is now shown that the charged ( $\text{CO}_2$ ) radicle of the carboxylic acid ion behaves as if it were a single atom, and that on this conception the relative strengths of most *meta*- and *para*-substituted phenols, anilines, and benzoic acids are in excellent harmony with the application previously made of the principle of induced alternate polarities to the affinity constants of the cresols. (2) Replaceability of halogen atoms by hydrogen atoms: a general rule. Some ions, such as  $\text{H}^+$  and diazonium ions, some elements, including ozone, the halogens, and some compounds, including hypochlorous acid, carbonyl compounds, and  $\alpha\beta$ -unsaturated ketones, etc., have some properties in common and are termed "cationoid." Ions, such as  $\text{CN}^+$ ,  $\text{C C R}^+$ ,  $\text{OEt}^+$ ,  $\text{OH}^+$ , the negative ions of *sodio*-malonic ester, and some non-ionised compounds such as  $\text{NH}_3$ , ethylenic and acetylenic hydrocarbons, phenol ethers and vinyl ethers, have other properties in common, and are termed "anionoid." The "anionoid" properties of ethylenic hydrocarbons are held to be closely related to Thomson's observation that methyl is frequently observed in vacuum tubes with a positive charge, but never with a negative charge. The addition of a negatively charged ion to one of a pair of doubly-bound carbon atoms would leave the other as a tervalent carbon atom with a negative charge. These generalisations are closely related to the ease of replaceability of a halogen atom by hydrogen, and the following rule is stated: If  $\text{X-H}$  is an acid or compound in which H may be displaced by the direct action of an alkali or of a metal, then the halogen in  $\text{X-Cl}$ ,  $\text{X-Br}$ ,  $\text{X-I}$  will have some "cationoid" properties, and will be easily replaced by hydrogen. This rule is true whether  $\text{XH}$  is a so-called "tautomeric system" or not.

## PARIS

Academy of Sciences, March 9.—A. Desgrez, H. Bierry, and L. Lescœur: The blood globules and alkaline reserve.—S. Winogradsky: A method for estimating the nitrogen fixing power of soils. The medium chosen is a silica gel, for the preparation of which exact details are given. The number of azobacters is determined in the course of the operation, the amount of nitrogen fixed being estimated by the usual Kjeldahl method. It is claimed for the method that it can be used by agricultural chemists who are not experts in microbiology.—Luc Picart was elected corresponding member for the section of astronomy in succession to the late M. Stéphan.—Sir John Russell was elected a corresponding member for the section of rural economy in succession to M. Winogradsky, elected foreign associate.—M. Légaut: Skew algebraic curves.—Gaston Julia: Series of iteration and quasi-analytic functions.—Pierre Humbert: Zonal hyperspherical functions.—Léon Pomey: The theorem of existence and two modes of representation of the solutions of ordinary differential equations.—W. Stozek: The direction of harmonic functions in the neighbourhood of an exceptional point.—A. Lafay: The eddy currents of rotating cylinders.—Léon Bloch,

Eugène Bloch, and Georges Déjardin: The spark spectrum of neon. Wave-lengths and intensities of the lines of the neon spark spectrum are given for wave-lengths between 4922 and 2757.—M. Charron: The resultants of the radiation pressures on the walls of any cavity whatever.—Pierre Goby: Stereoscopic microradiography in relief and in pseudo-relief: the stereomicrodiograph.—Stefan Triandafil: The influence of acidity on the galvanic polarisation of nickel.—Tourneux and Mlle. Pernot: The aqueous and acetone solutions of potassium bromo- and iodomercurates.—Fred Vlès and Edmond Vellinger: Remarks on the variations of the rotatory power of tartaric acid as a function of the  $P_H$ . The relation between the rotatory power and hydrogen-ion concentration of tartaric acid has been studied experimentally over the range  $P_H$  0-14. By applying the usual formula for the dissociation equilibria of dibasic acids and calculating the rotation as the sum, for each  $P_H$ , of the rotations of the two ions and its residue of dissociation, the experimental results are explained.—Lemarchand: The carrying down of magnesium by calcium oxalate.—Yvon: Syntheses made starting with the sodium derivative and the mixed magnesium derivative of methylacetylene.—H. Rosset: Phosphorus chloronitride.  $PNCl_2$  treated in toluene solution with phenylmagnesium bromide gave as one of the products of the reaction the compound  $(PN(C_6H_5)_2)_3$ . The constitution developed for this substance is based on the formula attributed to phosphorus chloronitride by Wichelhaus and Stokes.—Marcel Godchot: The two 1,3-dimethyl-4-cyclohexanones and the corresponding dimethylcyclohexanols. The existence of four 1,3-dimethylcyclohexanols is proved.—A. Demolon: The texture of the quaternary sediments and the soils derived from it.—Jovan Cvijic: The Merokarst.—L. Lutz: The specificity of some hymenomycetes growing on wood. Some of these fungi grow exclusively on certain species of plants, and this peculiarity has been supposed to be due to the presence in these plants of substances necessary to the life of the parasitic fungi. The experiments described tend to show that the specificity of these fungi is not due to the presence of suitable nutritive substances, but, on the contrary, to the presence or absence of certain substances injurious to the growth of the fungus.—J. Nageotte: The extreme contraction of striated muscle in the frog.—Léon Blum and Maurice Delaville: The study of the modifications of the blood and humours by ultrafiltration.—A. Rochon-Duvigneand, E. Bourdelle, and J. Dubar: The determination of the monocular anatomical visual field of the horse by the method of the transcleral image.—Abelous, Argoud, and Soula: The structural modifications of certain organs, especially the pancreas, in animals without spleen.—L. Mercier and Raymond Poisson: Hens with crossed beaks. A coaptation of mechanical origin.—Robert Weill: Experimental retardation of the nematocysts in the *Cœlenterata*. Rendering permeable the capsular wall.—Boris Ephrussi: The fecundation membrane of the egg of the sea-urchin (*Paracentrotus lividus*). The action of the coelomic liquid.

March 16.—Paul Appell: Extension of a theorem of Monge.—P. Widal, P. Abrami, Diaconescu, and Gruber: Digestive hæmoclasia and the state of neuro-vegetative tonus. Objection has been taken to some of the earlier experiments published by the authors on the ground that there is insufficient proof that the results are wholly due to the condition of the liver. Additional experiments have been carried out, specially arranged to test the validity of this objection. The results confirm the original experiments.—André Blondel:

A method of harmonic analysis of the waves of alternating currents by comparison with a poly-harmonic standard alternator.—J. B. Senderens: The preparation of cyclohexenols by the catalytic dehydrogenation of cyclohexanediols. By testing the cyclohexanediols (resorcite, quinite) with from 3 to 4 per cent. of diluted sulphuric acid ( $H_2SO_4 + 3H_2O$ ) a mixture of cyclohexadienes and cyclohexenol is obtained, and the conditions can be arranged to give either the hydrocarbon or alcohol as the main product. Details of the preparation, properties, and reactions of  $\Delta_2$ -cyclohexenol from resorcite and from quinite are given.—Ph. Glangeaud: The rôle of the secondary volcanoes in the Monts Dore massif during the glacial periods. The volcano of Saint-Pierre-Colamine (Puy-de-Dôme). The existing topography of the Sancy volcano is the result of the action of numerous secondary volcanoes arising on its sides, afterwards brought into relief by glacial action.—M. René Kœhler was elected a corresponding member for the section of anatomy and zoology.—Kraitchik: Fermat's numbers.—G. Y. Rainich: A representation of surfaces.—Paul Urysohn: A metric universal space.—Maurice Fréchet: The notion of the differential in general analysis.—Henri Milloux: Meromorph functions with asymptotic value and the theorem of Picard.—St. Kempisty: A new method of integration of measurable functions not capable of summation.—J. Guillaume: Observations of the sun made at the Observatory of Lyons during the fourth quarter of 1924. Details of observations on spots and faculæ made on 60 days during the quarter.—Aubusson de Cavarlay and Descours Desacres: An automatic method of drawing roads. The apparatus, placed upon a vehicle moving over a road, records the plan of the road in three dimensions.—F. Baldet: The third negative group of carbon, the so-called comet-tail spectrum. Extension of the red end and the structure of the bands. The carbon monoxide was under a pressure of  $10^{-4}$  mm., the spectrum being induced by electronic bombardment, with 20 minutes' exposure of the plate. This reproduces exactly, with the same relative intensities of the bands, and in the minutest detail, the well-known comet-tail spectrum.—J. Laffay: The spark spectrum of mercury in the extreme red.—Jean Lecomte: The infra-red absorption spectrum of the alcohol function. By the use of a fluorspar prism, the region  $2.75\mu$  to  $8\mu$  has been studied. The mono-alcohols show two zones of strong absorption: from  $3\mu$  to  $3.5\mu$  and from  $6.85\mu$  to  $8\mu$ . Details of the absorption bands of twenty-six alcohols are given.—E. Huguenard, A. Magnan, and A. Planiol: A hot-wire apparatus for the determination of great altitudes. A modification of the hot-wire anemometer: at a height of 14,000 metres its sensibility is nearly eight times that of a barometer.—Mlle. Irène Curie: The homogeneity of the initial velocities of the  $\alpha$  rays of polonium. There are no indications of differences of initial velocities of the  $\alpha$  rays of polonium. If uniform distribution of velocities is assumed, the extreme deviation does not exceed 0.3 per cent.—Louis Jacques Simon: The relation between the structure of the unsaturated mono-carboxylic acids and their comparative sulphochromic oxidation.—J. Orcel: Two clinoclones containing chromium from Togo.—Jean Jung: Some types of crushed rocks from the Vosges.—Louis Barrabé: The nature of an eruptive massif, the "Antatika-Ambereny," from the west of Madagascar.—L. Cayeux: The relative age of the phthanites and dolomites of the carboniferous limestone of the North of France and of Belgium.—J. Savornin: The Djebel Ayachi (Morocco)—J. Thoulet: Submarine volcanoes at great depths.—Gabriel Guilbert: The causes

of the rapid destruction of cyclones.—Paul Guérin : The anther of the Gentianaceæ. The development of the pollen sac.—Pierre Lesage : Extension of acquired character and facts of heredity in *Lepidium sativum* watered with salt water. The alteration in the seed produced by salt water is an acquired character preserved after three generations in the absence of salt.—A. Maige : The evolution and "greening" of the plasts in the cotyledon cells of various leguminous plants during germination.—M. Bridel and C. Charaux : On an unstable glucosidic complex in the bark of the stem of *Rhamnus cathartica*. A complex glucoside extracted from the bark gives on hydrolysis primeverose and derivatives of oxymethylanthraquinone.—E. and G. Nicolas : Hexamethylene-tetramine can serve as a food for plants. New researches on bean and white mustard.—Mlle. F. Coupin : The state of the brain at birth in the chimpanzee.—R. Herpin : Egg production and development in a sedentary polychetal annelid, *Nicolea rostericola*.—Auguste Lumière : Some new anticoagulating bodies of definite chemical composition. Of eighteen compounds studied, five have shown a high anticoagulating power. Of these, sodium mucate is anticoagulating at a concentration of 0.4 per cent. and has no toxic power.—Emile F. Terroine and H. Spindler : The influence of various methods of pasteurisation by heating on the digestibility of the albumenoid and mineral constituents of milk. Three methods were compared : heating to 63° C for 25 minutes with stirring, heating to 95° C, and the Stassano method. None of the methods interferes with the digestibility of the milk.—Jules Amar : Mercurial poisoning and vital coagulation.—A. Malaquin : The germinal cells (gonocytes) are, in the course of the asexual reproduction of *Salmacina Dysteri*, the source of the blastogenic proliferation.—Marc Romieu : A new chemical reaction of dry proteid materials applicable to histochemistry. Sirupy phosphoric acid at about 50° C gives a purple changing to violet with proteids. It appears to be a tryptophane reaction and is not given by gelatin.—Ph. Joyet-Lavergne : The reactions of a tissue to parasitism ; lipoidogenesis and lipogenesis.

## ROME.

Royal Academy of the Lincei, December 7.—Gabriella Armellini Conti and G. Armellini : Visual brightness of lunar seas. The fact that the mean brightness of lunar seas is about 0.048 and that of the land areas about 0.096 indicates that the seas represent gigantic laval and basaltic lakes, whereas the land area is constituted largely of trachite and pumice.—M. La Rosa : Radial velocities and the ballistic theory of variable stars.—Luigi Palazzo : Magnetic determinations in the larger islands of the Mediterranean Sea.—Secondo Franchi : New traces of overthrust in the Western Alps.—Mario Manarini : The problem of primitive functions.—Paolo Stranco : Deduction and interpretation of some Einsteinian  $ds^2$  symmetrical about an axis.—L. Matteuzzi : Determination of forced and free seiches by means of a Volterra's integral equation of the second species.—Bruno Finzi : A new hydrodynamic paradox.—Vittorio Nobile : The possibility of a rigorously rational arrangement of the fundamentals of stellar position astronomy.—Giorgio Abetti : Spectroscopic parallaxes of the stars belonging to Secchi's first type.—Remo de Fazi : Studies on the indones. VI. Methods of preparing indones.—P. Leone : Organo-metallic compounds of aluminium. Various aluminium alkyl halides and also aluminium phenyl iodide have been prepared by boiling the alkyl halides, in very dry condition, with metallic aluminium.—Paolo Principi :

New observations on the geology of the deep valley of Tevere.—E. Onorato : Celestine from S. Gaudenzio (Senegal).—E. Caroli : A cavitied Mysidacea (*Spelæomysis bottazzii*) from Terra d' Otranto.—S. Sergi : The myorabdotic cellular groups of the lumbosacral region of the spinal medulla of the chimpanzee.

January 18.—F. Cavara : Floral atrophy in *Phoenix dactylifera* from Cyrenaica. The atrophy to which the male flower of the date palm is sometimes subject in the neighbourhood of Benghazi is shown to be due to attack by an organism which belongs to the Mucedineæ and is reproduced only by conidia ; for this organism, previously not described, the name *Maugimella Scaetta* is proposed.—Fil. Bottazzi : Influence of temperature on the tissues and on their colloidal components. VII. Rigidity caused by cold.—Luigi Fantappiè : Reduction of Pincherle's distributive operations to Volterra's linear functionals.—F. Vercelli : Results obtained during the cruise of the Italian royal ship *Marsigh* in the Straits of Messina. This paper consists solely of tidal data.—E. Fermi : Collision between hydrogen nuclei and atoms. The collision between a nucleus and an atom of hydrogen results finally in two nuclei and an electron, all separate. When the relative energy of the collision is greater than that of ionisation, ionisation may occur continuously.—Maria De-Angelis : Presence of vesuvianite in the asbestiferous deposits of Val Malenco.—Roberto Savelli : Transmission of mutations through inter-specific hybridisations ; procedure in the first series of experiments. Apart from its great technical limitations, inter-specific hybridisation repeats the results of pure succession and shows that, whether the direct physiological cause of the somatic extrinsecations of the mutation be of hormonal or other character, its genetic substrate consists of a Mendelian unit.—Mario Gianotti : Variations produced in the ammonia content of the blood by exertion at high and low altitudes. During a state of rest, the blood of a human being at a great altitude (more than 4000 metres) contains more ammonia than on the plains ; this phenomenon may be explained by the acapnia produced by rarefied air. Since, then, the blood exhibits diminished alkalinity at a height, fatigue will the more readily result in a condition of acidosis which will require the circulation of abnormally large amounts of ammonia.—A. Rabbero : Action of sea-bathing on the reaction of the blood. Sea-bathing, during which continued swimming is indulged in, is followed, not only by vigorous pulmonary ventilation and increased elimination of carbon dioxide, but also by diminished power of the blood to resist changes in its reaction. The bases remaining in the blood are rapidly expelled, presumably by way of the kidneys.—Constantino Gorini : Further investigations on mammary microflora.

## VIENNA.

Academy of Sciences, February 12.—A. Bachofen-Echt. The discovery of iguanodon tracks in the Neocomian of the island of Brioni near Pola. Near Cape Rocca in Brioni the strata of Neocomian limestone are almost exactly horizontal. The massive slabs of easily worked fine-grained stone have been quarried back from the cliff edge. Ripple marks show that in the chalk era there was a flat shore here. Two sorts of tracks are found—a three-toed footprint 26 cm. long, another 13 cm. long, perhaps iguanodons of different ages ; also five-toed tracks, perhaps tortoises.—L. Waldmann. The geological structure of the primitive rocks between the Moldau and Danube on the survey sheet Gmünd. The principal rocks are orthogneiss, amphibolite, granulite, granite-gneiss, etc.—R. Danzer : Organic compounds of lead.

## Official Publications Received.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 285: Tides and Currents in New York Harbor. By H. A. Marmer. (Special Publication No. 111.) Pp. v+174. (Washington: Government Printing Office) 80 cents.

The Carnegie Foundation for the Advancement of Teaching. Nineteenth Annual Report of the President and of the Treasurer. Pp. vii+236. (New York.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 56: (a) *Crucians* in relation to Climate in Egypt and the Sudan. By C. B. W. ... Pp. ii+31+9 plates. Bulletin No. 56: The Buff-Backed Egret (*Ardea Ibis*, L., Arabic *Abu Qerdan*) as a Factor in Egyptian Agriculture. By T. W. Kirkpatrick. Pp. ii+28. (Cairo: Government Publications Office.) 5 P.T. each.

Board of Education. Syllabus of the Science Scholarships Examination, 1926. Pp. 24. (London: H.M. Stationery Office.) 6d. net.

Sixth Annual Report of the Governors of the Imperial Mineral Resources Bureau. Pp. 25. (London.)

Stonyhurst College Observatory. Results of Geophysical and Solar Observations, 1924, with Report and Notes of the Director, Rev. A. L. Cortie. Pp. xix+44. (Blackburn.)

The University of Chicago: Publications of the Yerkes Observatory. Vol. 3, Part 4: The Forms and Motions of the Solar Prominences. By Edison Pettit. Pp. v+205-240+plates 27-37. (Chicago: University of Chicago Press.)

University Grants Committee. Report, including Returns from Universities and University Colleges in Receipt of Treasury Grant, Academic Year 1923-1924. Pp. 44. (London: H.M. Stationery Office.) 3s. 6d. net.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 54, 1924, July to December. Pp. 211-370+15+x. (London: Royal Anthropological Institute.) 15s. net.

United States Department of Agriculture. Department Bulletin No. 1281: Relative Utilization of Energy in Milk Production and Body Increase of Dairy Cows. By J. August Fries, Winifred Waite Brame and Donald C. Cochran. Pp. 86. (Washington: Government Printing Office.) 10 cents.

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 31: Statistics of State School Systems, 1921-22. Prepared under the Direction of Frank M. Phillips. Pp. 5 cents. Bulletin, 1924, No. 38: Statistics of State School Systems, 1922-23. By Frank M. Phillips. Pp. 30. ... Trend of College Entrance Requirements, 1913-1922. By Harry Charles McKown. Pp. iv+172. 20 cents. (Washington: Government Printing Office)

Records of the Albany Museum. Vol. 3, Part 4, March 6th. Pp. 257-368+1 ... 10s.

Ministry of Public Works, Egypt: Physical Department Paper No. 17: The Upper Currents of the Atmosphere in Egypt and the Sudan. By L. J. Sutton. Pp. iv+136+18 plates. (Cairo: Government Publications Office) 10 P.T.

Reports of the Council and Auditors of the Zoological Society of London for the Year 1924, prepared for the Annual General Meeting to be held at the Society's Offices in Regent's Park on Wednesday, April 29th, 1925. Pp. 79. (London.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 54: Notes on the Fungus *Rhizopus Nigricans* Ehr., in Relation to Insect Pests of the Cotton Plant in Egypt. By T. W. Kirkpatrick. Pp. ii+28. (Cairo: Government Publications Office) 5 P.T.

British Museum (Natural History). British Birds: Summer Visitors. Series No. 2, Set C18. 5 picture postcards. 1s. Series No. 2, Set C14. 5 picture postcards. 1s. British Flowering Plants. Series No. 5, Set F8. 5 picture postcards. 1s. Series No. 6, Set F9. 5 picture postcards. 1s. Crustacea. Series No. 1: Crabs and Lobsters. Set L1. 5 picture postcards. 6d. Colour Changes in Flatfishes. Set M2. 5 picture postcards. 6d. (London: British Museum (Natural History))

## Diary of Societies.

SATURDAY, APRIL 25.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. P. Pycraft: Use and Disuse and their Effect on the Bodily Structure of Animals (I.).

MONDAY, APRIL 27.

ROYAL IRISH ACADEMY, at 4.15.

INSTITUTE OF ACTUARIES, at 5.—W. Palm Elderton and A. H. Rowell: Some Aspects of the Valuation Statistics.

INSTITUTE OF ELECTRICAL ENGINEERS (Graduates' Section, London), at 7.—Evaluation of Industrial Kinematograph Films

INSTITUTE OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.—Annual General Meeting.

INSTITUTE OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—M. Platt: The Accessibility of the Pleasure Car Chassis.

ROYAL SOCIETY OF ARTS, at 8.—Prof. J. S. S. Brame: Motor Fuels (Howard Lectures) (II.).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Clinical Evening.

FARADAY SOCIETY (at Chemical Society), at 8.—A. E. Ollard: Adhesion of Deposited Nickel to the Base Metal.—H. Sutton: The Brittleness of Zinc Plated Steel.—W. A. Naish: The Partition of Silver between Lead and Zinc.—H. J. Poole: The Elasticity of Gases.—H. J. Poole: Note on their Physical Structure.—H. J. Poole: Note on the Reduction of Viscosity.—H. J. Poole: Note on the Viscosity of Molecular Weight.

ROYAL SOCIETY OF ARTS (at Eolian Hall), at 8.30.—C. P. Skrine: The Alps of Kungur.

TUESDAY, APRIL 28.

ROYAL DUBLIN SOCIETY (at Royal College of Surgeons, Dublin) at 4.15.—Dr. H. H. Poole: The Use of Polarized Light in Submarine Photography.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: Some Effects of Climate on the Circulation (II.).

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Prof. E. Leschke: Metabolism and the Sympathetic System.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—D. M. Proctor: Steam Accumulation.

INSTITUTION OF ARTS, at 7.—M. Platt: The Use of Polarized Light in Submarine Photography.

INSTITUTE OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—C. Friese-Greene: Latest Improvements in the Friese-Greene Colour Process.

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—Annual General Meeting.

WEDNESDAY, APRIL 29.

INSTITUTE OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.

ROYAL SOCIETY OF ARTS, at 8.—Dr. A. Balfour: The Trend of Modern Hygiene.

THURSDAY, APRIL 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—F. Kingdon Ward: The Use of Polarized Light in Submarine Photography.

ROYAL SOCIETY OF ARTS, at 8.—Dr. C. W. K. ... Progress of Child Study in America.

INSTITUTE OF CIVIL ENGINEERS (Birmingham and District Association) (at Chamber of Commerce, Birmingham), at 6.

FRIDAY, MAY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—Annual Meeting

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—Dr. S. S. Zilva: Recent Progress in Vitamin Research.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Pictorial Group.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. A. Fairfax: Pumps and Pumping Problems

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.

PHILOLOGICAL SOCIETY (Anniversary Meeting) (at University College), at 8.—Presidential Address.

ROYAL SOCIETY OF MEDICINE (Anesthetics Section), at 8.30.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. L. Bragg: Crystalline Structure of Inorganic Salts.

SATURDAY, MAY 2

ROYAL SOCIETY OF MEDICINE (Otolaryngology Section), at 10.30.—Annual General Meeting

ROYAL INSTITUTION OF GREAT BRITAIN, at 8.—W. P. Pycraft: Use and Disuse and their Effect on the Bodily Structure of Animals (II)

## FREE PUBLIC LECTURES.

MONDAY, APRIL 27.

KING'S COLLEGE, at 5.30.—Prof. R. Chambers: Recent Advances in the Study of Living Cells. (Succeeding lectures on April 28 and 29.)—Prof. R. Dybowski: History and Geography of the New Polish State.

WEDNESDAY, APRIL 29.

INSTITUTE OF PHYSICS (at Royal Society), at 5.30.—Dr. W. Makower: Physics in the Rubber Industry, with special reference to Tyre Manufacture.

THURSDAY, APRIL 30.

KING'S COLLEGE, at 6.30.—Dr. O. Vočadlo: The Czechoslovak Republic To-day: Geography of the State.

FRIDAY, MAY 1.

UNIVERSITY COLLEGE, at 11.—Prof. A. V. Hill: The Physiology of Muscle and Nerve. (Succeeding Lectures on May 8, 15, 22.)

KING'S COLLEGE, at 5.—Dr. A. W. Rogers: Physical Features of South Africa in relation to its Geological Structure and History. (Succeeding Lectures on May 8 and 15.)—At 5.30.—Prof. F. J. Cole: The History of Protozoology. (Succeeding Lecture on May 8.)



SATURDAY, MAY 2, 1925.

## CONTENTS.

	PAGE
Benefactions to Universities: British and American	629
The Greatness of Galton . . . . .	631
Colloid Chemistry. By E. H. . . . .	634
Water Plants . . . . .	635
Our Bookshelf . . . . .	636
Letters to the Editor :	
The Effect of the Earth's Rotation on the Velocity of Light.—Sir Joseph Larmor, F.R.S.; Dr. J. H. Jeans, Sec. R.S. . . . .	638
The Dinosaur Region in Tanganyika Territory.—Sir Sidney F. Harmer, K.B.E., F.R.S. . . . .	638
Method of Measuring Deep Sea Tides.—Dr. Hans Pettersson . . . . .	639
An Amphoteric Substance in the Radula of the Whelk ( <i>Buccinum undatum</i> ).—C. F. A. Pantin and T. Howard Rogers . . . . .	639
Ball Lightning Phenomena.—Ben Davies . . . . .	640
Sound Production by Insects.—W. S. Bristowe . . . . .	640
A Method of Determining the Frequency of a Tuning Fork.—Prof. J. B. Seth . . . . .	641
Change of Linkage in Poultry with Age.—J. B. S. Haldane and Dr. F. A. E. Crew . . . . .	641
The Biological Action of Light. By Prof. Leonard Hill, F.R.S. . . . .	642
The Continents and the Origin of the Moon. By Dr. R. H. Rastall . . . . .	646
Obituary :—	
Sir Rickman John Godlee, Bart. . . . .	648
Sir D. Goldsmid-Stern-Salomons. By A. R. . . . .	648
Current Topics and Events . . . . .	649
Our Astronomical Column . . . . .	653
Research Items . . . . .	654
The Royal Meteorological Society. By R. C. . . . .	657
The British Science Guild . . . . .	658
Excavations at Cresswell Crags, Derbyshire . . . . .	658
Natural History of Disease in Baltimore, Maryland . . . . .	659
University and Educational Intelligence . . . . .	659
Early Science at Oxford . . . . .	660
Societies and Academies . . . . .	661
Diary of Societies . . . . .	663

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## Benefactions to Universities: British and American.

ANY attempt to apply to such matters as gifts and bequests to universities the methods of scientific investigation is beset by peculiar difficulties. To begin with, no complete tabulated statistics of such benefactions are in existence. Many of them are not in the form of money, and their money value is not easily ascertainable; public announcements of gifts of houses and lands often do not indicate their value, and bequests are often subject to indeterminate charges, or in the form of residuary estates regarding which no further public announcement is made. The figures to be given in this article have, therefore, no pretensions to exactitude. Further, if we proceed to use available data, such as they are, for purposes of comparison, inference, and prediction, it is soon apparent that the flow of benefactions is as little subject to ascertainable laws and its course as difficult to predict as if it were "the gentle rain from heaven." An illustration of this difficulty is afforded by comparing the benefactions, as recorded in the "Universities Yearbook," of the years 1913-14 and 1923-24.

The high cost of living, the crushing weight of taxation, and the general exhaustion entailed by our huge war expenditure, seemed bound to affect adversely the stream of benefactions; a stream fed from that comparatively small portion of private fortunes which is left over after the more imperative claims have been met. This margin at the free disposition of the possessor has, in too many instances, been squeezed out of existence. Nevertheless, the stream shows no signs of drying up. The tale of gifts and bequests to universities and university colleges in Great Britain and Ireland during the year 1923-24 amounts to 898,000*l.*, while the corresponding total for the last pre-War year is 292,000*l.* The former total includes, it is true, gifts from the Rockefeller Foundation of America, amounting to 243,000*l.*, but, even when these are deducted, the balance, 655,000*l.*, represents an effort far greater, presumably, than was exerted ten years ago in the same way. Two large recent gifts, one of 250,000*l.* by the Right Hon. T. R. Ferens, Lord High Steward of Hull, as a nucleus of a fund for the founding of a university college for that town, and an anonymous gift of 50,000*l.* to the Royal Technical College, Glasgow, suggest that the record of 1924-25 is not likely to show a falling off.

Substantial though these figures are, they do not bear comparison with the record of transatlantic benefactions. Last December, within one week, gifts for university purposes in the United States amounting to more than 11,000,000*l.* were announced: Mr. James B. Duke, of Charlotte, in the State of North Carolina,

created a trust fund of forty million dollars for the establishment of a university in that State, and Mr. George Eastman, founder of the Eastman Kodak Company, made gifts of eight and a half million dollars to the University of Rochester, N.Y., to which he had already given many millions, four and a half millions to the Massachusetts Institute of Technology (bringing the total of his gifts to this Institute to fifteen millions), and two millions, contingent on gifts of a like total amount from others, to the Hampton Institute, the Tuskegee Institute, and other institutions for the education of negroes.

The United States Bureau of Education has recently published a bulletin, No. 20 of 1924, containing statistics of universities, colleges, and professional schools for the year 1921-22. These include the following particulars of benefactions: total of gifts and bequests reported for the year—77 million dollars, or, say, 16,000,000*l.*; number of institutions which received gifts of more than 100,000 dollars, 105; amount of such gifts, 66 million dollars. The corresponding figures for the universities and university colleges of Great Britain and Ireland are, for 1923-24: total (as already stated)—898,000*l.*; number of institutions which received gifts and bequests amounting to 20,000*l.* or more, 13; amount of such gifts and bequests, 748,000*l.* It will be seen that the total is about one-eighteenth, or, deducting Rockefeller gifts, one twenty-fourth part of the American total.

One may safely attribute this disparity in some measure, at any rate, to the effects of the War: the damage suffered by Britain being enormously greater than that suffered by the United States, whilst the annual payments on account of our war debt to America enormously diminish that freely disposable margin of wealth from which alone our benefactions can come, and swell *pari passu* the corresponding margin in the United States. It is perhaps not too fanciful to suppose that one may discern in the recent very large gifts from the Rockefeller Foundation Trustees and other American benefactors to British universities a magnanimous effort to redress the balance. An examination of statistics for 1913-14, however, indicates that even before the War, benefactions to British universities were but a small fraction, one-fourteenth of those to American.

Tribute should here be paid to the generosity of those American benefactors who have recently founded numerous valuable fellowships tenable in the United States by British graduate students. The latest and largest of these foundations, that of the Commonwealth Fund of America, will, when fully in operation, maintain some 50 British graduate students in universities in the United States.

Statistics relating to higher education in the United States are very comprehensive. The "Universities Yearbook" of the British Empire, from which the figures given above for Great Britain and Ireland are taken, includes no returns from colleges or professional schools which are not either incorporated in or schools of the universities or in receipt of Treasury grants. Mr. Simpson Gee left 20,000*l.* last year to one of these excluded colleges (Leicester), and there were no doubt other similar bequests and gifts to such institutions. Comparison with American statistics is further vitiated by the circumstance that much of the work of the colleges which send returns to the United States Bureau of Education corresponds more nearly with that of the higher forms of British public and [secondary] schools than with work done in our universities. A better basis of comparison is obtained by dividing the total amount of benefactions by the number of students in the institutions included in the returns. This gives: for the United States in 1910 and 1920 respectively, 70 and 165 dollars per student, and for Great Britain and Ireland in 1913-14 and 1923-24, 7*l.* and 12*l.*

A very large number of the gifts and bequests received by American universities, especially the private universities, come from their alumni, and not only are these much more numerous than the alumni of British universities (the number of university and college students in the United States, excluding those in preparatory departments, was 550,000 in 1921-22), but also a much larger proportion of them make their careers in commerce and industry. Commenting on the attachment which links every American "college man" to his Alma Mater, Prof. Caullery wrote in 1917 (in "Universities and Scientific Life in the United States"): "Its force and prevalence are one of the undeniable marks of an idealistic side in the American mentality. And of course the universities are carefully on the watch to maintain it. . . . The university becomes the centre of a vast family, so much the more powerful, the more numerous it is. . . . Gifts to universities have thus become a normal element of the civic activity of the wealthy class. . . ." So important and so normal a source of income have such gifts become that one of the principal functions of the president of a (private) university is, says Caullery, to "adroitly rouse the generosity of the alumni."

There are signs that as industry and commerce attract, as they are doing, more and more men from British universities, and among them, doubtless, more and more potential millionaires, this particular source of university income is likely to be more productive than it has been in the past. When, a few weeks ago, Lord Balfour, as Chancellor of the University of Edinburgh, addressed a meeting of the recently formed

Alumni Association, he pointed out, in the course of an eloquent appeal which ought to be broadcasted wherever university men are to be found, that the university "has a right to ask those who are not millionaires, especially those who in their day have profited from her services, now to aid in maintaining the provision for the successive generations that pass through her classrooms" and, an American would add, her halls and stadia. On the same occasion, Sir Harold Stiles, the first president of the Association, was able to announce a gift of 1000*l.* from one of his former pupils, now resident, by the way, in the United States.

A characteristic of British as compared with American benefactions is the greater particularity with which benefactors specify the purposes to which they desire their money to be applied. Of 150 benefactions in 1923-24, 83 were for the encouragement of the study of specified subjects, 25 were for scholarships or bursaries, 9 for libraries, 9 for objects connected with corporate life such as hostels, unions, and sports grounds, and 5 for scientific or industrial research.

The whole subject of the influence of philanthropy in the history of higher education in the United States has been explored recently by Associate Prof. J. B. Sears, of the department of education in Stanford University, California, and the results of his researches were published by the Bureau of Education in Bulletin, 1922, No. 26. He directs attention to the steady increase in the benefactions for higher education during the forty years 1875-1915 from 3 million to 20 million dollars, but points out that the rate of growth of wealth of the United States was somewhat greater, and that of the *per capita* wealth far greater. Since 1915 the benefactions have increased almost fourfold. It would seem that on both sides of the Atlantic the War has led to a wider recognition of the national importance of higher education, as the great increase in the number of students indicates a wider recognition of its value to the individual. A belief in the value of education, alike to the nation and to the individual, has been general in the United States from their earliest times and may be traced to the character of the New England settlers. It is reflected strikingly in one of Prof. Sears's tables showing for the years 1893-1916 gifts and bequests classified under five heads: (1) educational institutions, (2) charities, (3) religious organisations, (4) museums, galleries, and public improvements, and (5) libraries. No less than 43 per cent. fall under the first head. A glance at the lists of bequests in "Whitaker's Almanack" shows that to the British testator educational institutions appeal much less strongly. To this difference of prevalent sentiment and estimation of values must be due in large measure the difference in magnitude between British and American benefactions to higher education.

### The Greatness of Galton.

*The Life, Letters and Labours of Francis Galton.* By Prof. Karl Pearson. Vol. 1: Birth 1822 to Marriage 1853. Pp. xxiv + 246 + 66 plates. Vol. 2: Researches of Middle Life. Pp. xii + 425 + 54 plates. (Cambridge: At the University Press, 1914-1924.) Vol. 1, 30*s.* net; Vol. 2, 45*s.* net.

THESE two stately volumes, which will be followed by a third, form a worthy memorial of a great man. It has been a labour of love to Prof. Karl Pearson to write them, a piety which must have cost him much, especially in the case of the second volume when the outer eye began to fail. He has earned the deep gratitude of all students of science, for besides giving us a living portrait, he has brought together a readable account of all the more important, not too technical, contributions that Galton made to science. The value of this is inestimable, for Galton scattered his papers widely, and many are not readily accessible.

The work is a sympathetic tribute to a master and a friend, and it is a fortunate fact that such a biographer was available. No one else could have done it with anything approaching the same success. The canvas is large, but every corner is significant and painted with the same loving carefulness. That the artist shows himself as well as his subject is the touch of perfection. It is also fortunate that it has been possible to reproduce so many photographs which would otherwise soon have been lost. The volumes are two galleries, showing us not only the development of the man and his many moods, but also his ancestry, and his own photographic experiments. The drawback is the inevitable, though marvellously moderate, expensiveness of the volumes. They are so exceptional and so rich in inspiration that we venture to suggest to some benefactor that copies should be sent to the departmental libraries of the relevant laboratories in the universities and colleges of Great Britain. It would sow for a big harvest.

The first volume was published about a month before the outbreak of the War, and has not received the attention that was its due. It begins with a careful and detailed account of Galton's noteworthy ancestry in many lines—an impressive study in heredity. Who, as he reads, can help feeling the value of good stock; and even if Francis Galton and Charles Darwin stand out as the pre-eminently happy combinations, they are certainly not alone in this lineage. This is not the place for argufying, but the biographer provokes it a little by the prominence he gives to Darwin's opinion—it has a whole page to itself—"I am inclined to agree with Francis Galton in believing that education and environment produce only a small effect on the mind of any one, and that most of our qualities are innate."

We must confess that this does not strike us as wise. No doubt, the fundamentally important thing is good seed, and neither soil nor sunshine can change bad seed into good. Yet they count for much, and Darwin was speaking of the individual. Galton was a happy blend of many very fine ancestral traits, but a good stock with fine hereditary "nature" usually secures for its progeny a generous "nurture"; and the outcome is a product of the two. We believe that psychical qualities are inherited like and along with the physical, but we do not feel at all convinced that what we call "the mind" develops altogether as "the body" does. The biographer admits that there was a period when Galton's fate seemed to hang in the balance. He might have subsided into a country gentleman, famous for his geniality and shrewdness, introducing ingenious devices in agriculture, probably a member for the county, possibly a M.F.H. We cannot produce any statistics, but experience suggests that the nurture of the innate qualities tipped the balance in the favour of science.

The story of Galton's school years makes one ashamed. Certainly this part of his nurture counted for little. "Anxious and willing to learn, he was given stones instead of the bread that he hungered for, and thus his chief school years were years of stagnation." Then came some stimulating holiday travel, a little medical education when he was 16 and 17 years of age, a journey down the Danube to Smyrna, and three years of mathematical education at Cambridge, which did not suit him particularly well and ended in over-strain and breakdown. So ended his apprenticeship, not too brilliantly. Of the "journeyman" years, 1844-1849, there is very little record, but there must have been much ferment and change. He deserted medicine and drifted from orthodoxy towards agnosticism; he visited Egypt and Syria; a chance meeting with a distinguished French exile, Arnaud Bey, had important consequences in suggesting scientific motives for Galton's future wanderings. But the shaping influences of this period are vague and the case for nurture is weak. Somehow, we know not how, Francis Galton grew into a purposeful man with re-awakened scientific interests. In 1853, at the age of thirty-one, he married Miss Louisa Butler, daughter of the Dean of Peterborough, and this calmly happy union lasted for forty-three years.

The second volume takes up the tale when Francis Galton was thirty-two, married, leisured, disciplined, much-travelled. "His experience had been such that he knew more of mathematics and physics than nine biologists out of ten, more of biology than nineteen mathematicians out of twenty, and more of pathology and physiology than forty-nine out of fifty of the biologists and mathematicians of his day." There was always catholicity in his scientific interests, but his

central enthusiasm was still for geography. This was the period of his "Art of Travel" (1855), with its wealth of practical ingenuity and penetrating insight, his attempts to lessen some of the gratuitous tragedies of the Crimean War, his secretaryship of the Royal Geographical Society, his invention of the hand heliostat and how many other devices, and his climatic and meteorological studies (including the suggestion of weather-charts and the discovery of "anticyclones"). Busy as he was, he found time to start (with Spencer and Norman Lockyer) a short-lived weekly journal called the *Reader*, which indirectly led to *NATURE*. "Pereat Lector, Natura resurgat."

During this period also Galton showed his open-mindedness by taking some interest in spiritualistic claims. His biographer speaks forcibly of those who do not doubt that the methods used for solving the problems of the phenomenal universe are adequate as instruments of research in "the unknown vast of the hyper-phenomenal."

"Such a man of science, possibly owing to a lack of epistemological study, forgets that his senses have been developed to grasp physical phenomena, that his concepts are deductions from his sensuous perceptions, and that neither his sensuous nor mental outfits are adapted for sensating, perceiving and conceptualising the hyper-phenomenal. Some men grasp this truth by the logic of reasoning, others by the logic of experience, others by a healthy instinctive appreciation, and some never grasp it at all. To the first group we may, perhaps, say Huxley belonged, to the second Galton, to the third Darwin, and to the fourth Crookes and Alfred Russel Wallace."

The centre of gravity of Galton's interests gradually shifted from man's environment to man himself. "About the time of the appearance of Darwin's 'Origin of Species' I had begun to interest myself in the Human side of Geography." We find him keenly interested in the domestication of animals, propounding the view that wild animals were tamed as pets or even kept for religious purposes before they were domesticated for food or transport. He was pondering over man's early gregariousness and he was thoroughly gripped by Darwinism. He laid the foundation-stone of his future anthropological work—the equal inheritance of psychical and physical characters—and he was profoundly moved by the ideal of the improvement of the human breed. His anticipations were remarkable; witness his grasp of the idea of the continuity of the germ-plasm, his rejection of the theory of the transmissibility of acquired characters, his emphasis on the survival value of affection, for animals as for man, his Law of Ancestral Heredity, and his investigation of heredity in twins. The biography gives us a very impressive picture, its Holbein detail contributing to reveal Galton's many-sidedness.

"Galton the Cambridge mathematician, Galton the ox-rider, Galton of the wave-machine, and Galton the eugenicist, seem at first sight so widely incongruous and yet, rightly estimated, are necessary features of that all-round individuality—observant, constructive, calculating, and enthusiastic—of Galton the anthropologist, using that term in its widest sense, who by originality of method, wide experience of men and ripe judgment of affairs, influenced the development of many younger men in the last quarter of the nineteenth century."

The next period was largely occupied with the study of heredity, and the biography gives us the gist of Galton's correspondence with Alphonse de Candolle. The Swiss botanist was interested in the history of men of science and was inclined to ascribe to environmental influence a larger rôle than Galton had allowed for in his "*Hereditary Genius*." After a certain amount of friction, the two men, who were emphasising complementary factors, became good friends and mutually inspired each other's work. The correspondence led to Galton's "*English Men of Science; their Nature and Nurture*" (1874). This was the period of Galton's prolonged experiments on the transfusion of blood, his criticism of Darwin's provisional hypothesis of pangenesis, and his further recession from the Lamarckian belief in the transmission of somatic modifications. There have been many great letters in *NATURE*, but there never was a finer than Galton's of May 4, 1871, a fresh revelation of the bigness of the man. We are glad to see prominence given to Galton's very important Royal Society paper of 1872 on "*Blood-relationship*," which has not been adequately appreciated; but we think there should have been more recognition of Weismann's later, but independent, work (1885) which struck the elusive mark of biologists' attention, missed, we think, by Galton.

There is inspiration for us all in the masterly chapter on Galton's psychological investigations, and he must be rather easy-going, we think, who can read it without reproaching himself for not having made more of Galton's suggestiveness and "generosity of ideas." Galton was one of the first, if not absolutely the first, to insist that anthropometry cannot make real progress without psychometric observation and experiment, and Prof. Pearson definitely claims for him a pioneer position in experimental psychology in Great Britain. The chapter deals with Galton's psychometric instruments, observations, and experiments, and with the conclusions reached in the "*Inquiries into Human Faculty and its Development*" (1883).

The possibility of some sort of communion with an indwelling divine Spirit was to Galton an almost life-long subject of thought.

"There is no subject more worthy of reverent but thorough investigation than the objective evidence for

or against the existence of inspiration from an unseen world, and none that up to the present time has so tantalised the anxious and honest inquirer with unperformed promise of solution."

We do not ourselves understand how an individual can hope to find nowadays any objective evidence of an unseen world which seems to some to be spiritually discernible, but Galton struck the religious note when he spoke of the possibility of "inspiration from an unseen world." His own tendril towards the absolute was a kind of pantheism; he asks whether "our part in the universe may possibly in some distant way be analogous to that of cells in an organised body, and our personalities may be the transient but essential elements of an immortal and cosmic mind." Apparently finding little satisfaction in this, Galton concentrated on an ethical evolutionism. In Prof. Pearson's words, Galton's position was:

"If the purpose of the Deity be manifested in the development of the universe, then the aim of man should be, with such limited powers as he may at present possess, to facilitate the divine purpose. Darwin for the first time gave a real history to living forms, and Galton following him said: Study that history, study the Bible of Life, and you will find your religion in it, and a new and higher morality as well. Thereby he raised Darwinism on to a higher, a spiritual plane."

This is well said, but when we contrast it with, for example, the phrase "inspiration from an unseen world," we see that the religious note, unless we are to rewrite history and redefine the term, has almost ceased to sound. "A new religion based on scientific knowledge"! It seems to us a contradiction in terms, for religious activity has always meant some kind of appeal—practical, emotional, or intellectual—that man, at the end of his tethers, has made to an order of reality beyond sense and science, "hyper-phenomenal," as Prof. Pearson would say. We have said that the religious note had almost ceased to sound in Galton's ethical evolutionism, but there was just a faint resonance inasmuch as he believed that man's application of the doctrine of evolution to the betterment of the human race meant bringing himself into line with the purpose of the universe.

In the closing chapter, which follows an account of Galton's photographic researches, there is an account of his many-sided statistical work. Here we find, to select one point only, a very interesting interchange of letters with Florence Nightingale, who was not only the "Lady of the Lamp," but also the "Passionate Statistician." She was full of the idea of a professorship of "Applied Statistics" and wrote to Galton on the subject. Here we may well quote Prof. Pearson again:

"For Galton and for Florence Nightingale the end and the means were the same: men must study the obscure purpose of an unknown power—the tendency behind the universe; and the manner of our study must be statistical. Therein, according to Francis Galton, lay the way to that unsolved riddle of 'the infinite ocean of being'; therein, according to Florence Nightingale, lay the cipher by which we may read 'the thoughts of God.' Men of the twentieth century may fail to appreciate the doctrine of either great Victorian, but of one thing they may be sure, the belief in both of them amounted to a religion. What was a religion to both became at once in both a motive for action."

It would indeed be a fine thing if Galton's purpose in founding a school of eugenics were continued in the establishment of a Nightingale chair of applied statistics. It is a pity that millionaires have so little imagination.

There are many impressions left after reading this biography—the versatility of the man, his generosity of ideas, his originality in blazing trails, his clearness of vision, his intensity of mental process, his magnanimity and kindness, and his sense of citizenship. We cannot end better than by endorsing the biographer's own words:

"Of one thing we are certain, that the reader, who will follow patiently our hero through the great and the little, the apparently trivial and the apparently vital incidents of this story, cannot fail to fall in love with a nature which met life so joyously, and from childhood to extreme old age was resolved to see life at its best and be responsive to its many-sided experiences."

### Colloid Chemistry.

- (1) *Les colloïdes*. Par J. Duclaux. (Actualités scientifiques.) Ouvrage couronné par l'Académie des Sciences. Troisième édition, entièrement revue et augmentée. Pp. viii+290. (Paris: Gauthier-Villars et Cie, 1924.) 15 francs.
- (2) *The Elements of Colloidal Chemistry*. By Prof. Herbert Freundlich. Translated by Prof. George Barger. Pp. vii+210. (London: Methuen and Co., Ltd., 1925.) 7s. 6d. net.
- (3) *Colloid Chemistry: an Introduction, with some Practical Applications*. By Jerome Alexander. Second edition, revised and enlarged. Pp. viii+208. (London: Chapman and Hall, Ltd., 1925.) 9s. 6d. net.

THE reviewer confronted with three works on the same subject, written by authors belonging to three different nationalities, is almost irresistibly tempted to enlarge on national character in scientific writing. To escape this temptation he has adopted the prudent course of leaving it to the reader to decide what part racial and what part individual characteristics bear in determining the difference in treatment.

(1) The author is one of the earliest and most determined representatives of the purely chemical school, and his work is an admirably lucid and elegant attempt to present the properties of colloids from this point of view. His type substance is colloidal ferric hydroxide sol, the particles of which are complexes of  $n$  molecules of ferric hydroxide to one of ferric chloride, which is ionised and causes the positive charge.  $n$  may vary from about 25 to 800, though with  $n > 400$  the sol becomes unstable. A similar "condensed" composition is postulated for other colloids, though the ionising group may be absent in those which are electrically neutral. Where this view encounters obvious difficulties, as in the sols of the noble metals, the author falls back on the impurities which are essential constituents of stable sols. He complains that many colloid chemists appear to have no use for the balance and the burette, and it is therefore curious that the work of Pauli, to whom this (not quite unjust) reproach certainly does not apply, receives no mention. More especially his work on silver sols is of fundamental importance; incidentally his careful investigations of ferric hydroxide sol lead to conclusions which differ from those of the author.

Adsorption receives critical treatment in the second half of the work; the author justly points out how much of the theoretical work has been done with so extremely ill-defined a body as charcoal, and on the whole concludes that the importance of adsorption in colloidal phenomena has been overrated. A reference to Freundlich's great "*Kapillarchemie*" leads up to the delightful statement, italicised in the original: "*il n'y a pas de chimie capillaire distincte de la chimie ordinaire.*"

The author's very original views on gel structure and on hydration unfortunately do not lend themselves to a short summary, but deserve careful study.

(2) Freundlich's "*Elements*" follows the general plan of the larger work mentioned above. After an introductory chapter, the phenomena at the various types of interfaces are described, and only then are colloid systems discussed in some detail. Both the electric charge on particles and electrolyte coagulation are ultimately traced back to adsorption. Even the less familiar disperse systems, like foams, smokes and solid dispersions, are not omitted, and, without devoting excessive space or special chapters to "applications," the author manages to give many striking instances to show how the study of colloids is providing explanations of natural phenomena.

Prof. Barger's translation is a faithful and—apart, perhaps, from a few hyphenated adjectives—idiomatic rendering of the original. In a note, which must command the sympathy of everybody who has had to write about the subject, he suggests that "a determined

attempt" should be made to find equivalents for the German verb "quellen" and the noun and adjective derived from it. The usual rendering "swelling" is certainly unsatisfactory, and the lack of an adjective and noun—though not by any means confined to this verb—leads to painful circumscriptions. It is to be hoped that purists will not be too violently upset by Prof. Barger's suggested terms: *turgesce*, *turgescible*, and *turgescence*.

The serious student of colloids cannot do better than to study Duclaux's and Freundlich's books together. If he finally arrives at the conclusion that his attitude for the present must be that defined by the venerable motto, "Nullius in verba," he will have no reason to regret the time spent on them.

(3) The plan of this book differs radically from that of either of the works just discussed. Nearly three-quarters of the total space is devoted to "applications" covering pretty nearly the entire range of human activities, and falling under the three heads with which the reader of the literature of colloids must be becoming familiar: problems which have been elucidated, problems which may some day be solved, and a large mass of material which is restated in a new terminology. This is not to say that these chapters do not contain many interesting things, but it is unreasonable to expect any sense of proportion in approaching them from a reader who has been provided with merely 54 pages of theory. The first section of this inadequate part, curiously entitled "Material Units," wastes space on brief excursions into relativity, isotopes, the size of the electron, and other topics the bearing of which on the subject is difficult to discover. Equally difficult is it to find any plan in the chapter on the general properties, which begins surprisingly with protection, and ends with half a page on viscosity. The whole book gives the impression of having been written with the intention of assisting in the very active propaganda for colloid chemistry which has for some time been carried on in the United States.

One feature, which could have been noticed in about a dozen books in recent years, may conveniently be mentioned here. In his first publication on the subject, Zsigmondy gave a plate showing various microscopic objects, and gave the magnification as "1:10,000." This singular way of describing a *magnification* has been copied religiously with the plate by a number of authors; in the book under review the figure has, in addition, been reduced to about two-thirds of the original size. These things are probably not sufficient (as Macaulay wrote on a similar occasion) "to make one despair of the human species," but they do throw a curious light on the way in which books are made.

E. H.

## Water Plants.

*Biologische und morphologische Untersuchungen über Wasser- und Sumpfgewächse.* Von Prof. Dr. Hugo Glück. Vierter Teil: Untergetauchte und Schwimmblattflora. Pp. viii + 746 + 8 Tafeln. (Jena: Gustav Fischer, 1924.) 45 gold marks.

THE extreme variability which water plants show under varying environmental conditions is well known. Almost equally well known are Dr. Glück's monumental studies on these plants, of which a further contribution is now available. This fourth volume of the series deals chiefly with the submerged and floating leaved floras of Europe and the Mediterranean regions, but it also contains a supplement to the third volume, which dealt with marsh plants. While reference is made to all the more important genera of water plants, the larger genera like *Ranunculus*, *Potamogeton*, and the water lilies naturally receive most attention.

Dr. Glück's method is to describe quantitatively, so far as is possible, the form variations observed either in Nature or under cultural conditions. He recognises these variations as being either of genetic origin or else as due to environmental conditions. Like its predecessors, this volume is noteworthy for the mass of new material recorded. The treatment of variation in *Nuphar* and *Nymphaea* is exceedingly well done, including as it does descriptions of the variability of the pollen grains and carpels. In dealing with other genera, the author points out that the summer leaf forms of many species are often strikingly different from those produced during winter. For example, the form of *Potamogeton crispus* known as *P. serratulus* Schr. (= *P. serratus* Huds.), with relatively narrower leaves, serrated margins, and longer internodes, has been grown in culture as the winter form of type plants. The forms found in running water often differ in a similar way from those of standing water. The internodes and leaves are relatively longer in running water, according to Dr. Glück, a good example being provided in *P. perfoliatus* var. *lanceolatus* Blytt.

It may be urged that the rôle of light intensity or of duration of exposure to light has been somewhat neglected by Dr. Glück. Many of the types described as winter forms or running water forms (as in the examples quoted) may occur in summer or in standing water if the water is sufficiently deep. Some of these forms have been produced recently by culture in light of low intensity. It is probable that this factor, which would operate in water, in running water or in deep standing water, is the common feature which produces longer internodes and smaller and narrower leaves under these natural conditions. The changes are those which, in more extreme form, are produced in etiolation.

For comparative purposes, therefore, the value of the numerous tables given in this book would have been greatly enhanced if data as to the depth of the water (and hence indirectly the light intensity), in which the various forms occurred, had been always included. This single criticism need not, however, prevent us from congratulating Dr. Glück on an exceedingly valuable contribution to the study of form variation and to aquatic biology.

### Our Bookshelf.

*Wettervorhersage: die Fortschritte der synoptischen Meteorologie.* Von Prof. Dr. Walter Georgii. (Wissenschaftliche Forschungsberichte: Naturwissenschaftliche Reihe, Band 11.) Pp. viii+114. (Dresden und Leipzig: Theodor Steinkopff, 1924.) 4.50 gold marks.

THE title chosen by Dr. Georgii for this work—"The Progress of Synoptic Meteorology"—is perhaps rather ambitious for a work which runs to no more than 111 pages. It is largely an account of the meteorological theories of V. and J. Bjerknes and of F. M. Exner, one might almost say of the Norwegian and Austrian schools of meteorology, but it contains also short accounts of certain lines of research not especially associated with these schools.

After the first introductory chapter, which describes the construction of synoptic weather charts, there follows a summary of the views of V. and J. Bjerknes on the origin and structure of the cyclones of temperate latitudes, together with a short account of Exner's theory of cyclonic formation as a result of the obstruction of the circumpolar easterly winds by mountain ranges. The third chapter deals with the travel of pressure and wind systems and of the weather associated with them; in other words, with the phenomena upon which the practice of synoptic forecasting rests. This discussion is in terms of the two schools of thought to which reference has already been made; the moving streams of air are regarded as more fundamental than the pressure-systems with which they are associated, a conclusion which had been reached many years ago by Sir Napier Shaw in Great Britain as a result of his investigation into the life-history of surface air currents. The account of Ficker's idea of "high" and "low" cyclones and anticyclones towards the end of this third chapter is a timely reminder that no theory of cyclones and anticyclones is complete which relies on temperature differences in the troposphere for explaining the differences of pressure between these systems, for it is well known that at a height of about ten kilometres, *i.e.* near the top of the troposphere, variations of pressure occur at least as large as those observed on the ground, and these are potent factors in the determination of the pressure at the level of the ground. It is natural, however, that in dealing with progress in synoptic weather forecasting, greater stress should be laid on the phenomena of the lower layers, about which we have abundant information.

Meteorologists will no doubt be grateful to Dr. Georgii for condensing into so small a space material scattered in numerous separate papers in several

languages, and where abbreviation has been perhaps excessive, references are always given, which enable the reader to consult those papers for fuller information.

*The Synthesis of Nitrogen Ring Compounds containing a Single Hetero-Atom [Nitrogen].* By Cecil Hollins. Pp. 423. (London: Ernest Benn, Ltd., 1924.) 55s. net.

It would be interesting to know how much time is annually expended in chemical laboratories in the preparation of carbon compounds, already recorded in the literature, but which their would-be discoverers believe to be new substances. The considerable waste of energy involved will, however, appear small if compared with that resulting from the choice of the less suitable methods of attack of a defined problem in organic synthesis. It cannot be said that existing safeguards, Beilstein, Richter, Stelzner, Meyer-Jacobsen, and the general indexes, are sufficient to protect us from these dangers.

Elb's "Kohlenstoffverbindungen" (1889) was an early attempt to meet this need, but the basis of the work was so broad that the execution of the plan seems a prodigious task at the present time, and only possible to a Mellor of organic chemical literature. Mr. Hollins has chosen a section of the heterocyclic compounds, cyclic substances with one ring nitrogen member, and has produced a compilation of very considerable utility, especially to those whose investigations touch the chemistry of the derivatives of pyrrole and pyridine. The arrangement of the material is excellent, and the information which the book can give is very readily accessible. The claim that the treatment is exhaustive is on the whole justified, but there are nevertheless omissions, for example, the list of *o*-nitrobenzaldehydes which have been converted into indigotins is incomplete. There are also inaccuracies such as the formula for dehydracetic acid given on pp. 188, 212, but neither the gaps nor the mistakes are so numerous as to detract seriously from the value of the book. The analogies which the author perceives as existing between certain synthetical methods are often suggestive, but the theoretical aspect is here of subsidiary interest and, though some of the views expressed can be vigorously contested, it is not an important criticism that the work is scarcely adequate as a treatise on reaction mechanism. Not only the author but also the publishers are to be congratulated on an enterprise unusual in English organic chemical literature.

R. ROBINSON.

*League of Nations: Committee on Intellectual Co-operation. Index Bibliographicus: International Catalogue of Sources of Current Bibliographical Information (Periodicals and Institutions).* Arranged and edited by Marcel Godet. Pp. xvi+233. (London: Constable and Co., Ltd., 1925.) 4s. net.

THE work before us is an International Directory of current periodical publications and card-indexing institutions which profess to keep their clients abreast of current progress in their respective branches by means of abstracts of papers, book reviews, or book lists. The work has been clearly conceived, and the material collected is well arranged, edited, and printed. Entries are numbered and classified by the Dewey

system, then rearranged by country of origin, and finally indexed alphabetically by titles.

A weak point in the past in all international ventures has been the inadequate central control. Here M. Godet deserves our commiseration rather than our censure. In his preface he shows that he has striven to infuse into his contributors his spirit of enthusiasm for international service. Nevertheless, he has failed—notably, we regret to say, in the case of the British contingent. Omissions we expected to find, but not omissions of the principal national sources of reference. Indeed, in many broad highways of literature, *e.g.* history, theology, education, law, geology, etc., we have failed to find a single British publication recorded. The following list of omissions will be sufficient to justify our criticism: as will be seen, it includes a few foreign entries. Bodleian Quarterly Record, Bulletin of the John Rylands Library, Special Libraries, *New Statesman* (Digest of Parliamentary Papers), *English Historical Review*, *Geographical Review*, *International Journal of Psycho-Analysis*, *Eugenics Review*, *Lancet*, *Hermes*, Architectural Association's Journal (Analytical Digest), Geological Society's Geological Literature, Royal Horticultural Society (Analytical Digest), *Jahrbuch der Radioaktivität*, *Science Progress*, *The Analyst*, *Zeitschrift für analytische Chemie*, *Zeitschrift für anorganische Chemie*, and the Zoological Society's Record. The list could be extended if space allowed. An exception to our remarks, however, should be made in the case of the British contributor to the Useful Arts. This section is fairly well covered.

*North Star Navigation*. By L. M. Berkeley. Pp. 86. (New York: The White Book and Supply Co., 1924.) 3.75 dollars.

It may be taken as an axiom in practical navigation that, so far at least as the northern hemisphere is concerned, no pair of observations can be depended upon to furnish with greater readiness and simplicity the true position of a ship than an altitude of Polaris—the Pole-star—in combination with that of some other star, observed about the same time on a reasonably large azimuth, and preferably in the neighbourhood of the prime vertical.

This is the problem dealt with in Mr. Berkeley's volume upon somewhat novel lines. The general practice is to reduce the altitude of Polaris to meridian by one or other of the numerous tables supplied for that purpose in the almanacs and collections of nautical tables, thus obtaining the latitude at once by simple inspection; while the zenith distance of the second star, that is, the complement of the altitude, forms the third side of a triangle in which the polar distance of the star, and the co-latitude, obtained as above, represent the other two sides. From these three sides the hour angle of the star can be calculated by the ordinary formulæ of spherical trigonometry, whence ship mean time and longitude easily follow.

The author of "*North Star Navigation*" employs methods of his own which, as compared with the procedure described above, can scarcely be said to gain anything in brevity or simplicity. Moreover, several special tables are required in the process proposed, two of which would appear to need recalculation year by year. The mathematical basis of the methods, however, is stated in the volume in minute detail, and will

perhaps arouse interest amongst astronomers and mathematicians, but it is scarcely likely that any great number of practical navigators will be tempted to exchange their old lamps for the new ones here set before them.

*Fundamentals of Bio-chemistry in relation to Human Physiology*. By T. R. Parsons. Second edition. Pp. xii+295. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1924.) 10s. 6d. net.

THE appearance of a second edition of this little work eighteen months after the first is itself a good recommendation, and this favourable impression is confirmed on closer acquaintance. It fills a definite gap in biochemical literature as a short, readable, and up-to-date account of the theoretical aspect of the subject as distinct from the practical. The chief additions made to this edition are a short account of the preparation and properties of insulin and a section on Werner's views of the constitution of urea. No criticism can be levelled at the subject matter or its presentation, which is admirable as a short introduction to the subject of biochemistry. Apart from a few typographical errors, there are one or two other lapses to be noted: thus the phrase "the excitation passes from muscle to nerve" is not particularly happy, whilst insulin is *not* administered "in the form of repeated *intravenous* injections" (the italics are ours), nor is the method of standardising insulin mentioned likely to prove satisfactory. These faults detract but little from the general high level of the book. The subject matter includes chapters on the chemistry, digestion, and metabolism of the foodstuffs, on physical chemistry, including the activity of enzymes, and on the respiratory gases.

*Mélanges de mathématiques et de physique*. Par Émile Picard. Pp. v+366. (Paris: Gauthier-Villars et Cie, 1924.) 25 francs.

THIS is a very miscellaneous volume. There are some obituary notices and discourses on anniversaries; an essay or two from reviews and reports; a chapter of a book; and two original papers. Everything that M. Picard writes is worth reading, but here he is usually reproducing arguments and views familiar to all who know his work. The personal articles are more distinctive; M. Picard excels in a form in which so many of his countrymen are eminent; the account of Abel's life and work is a model of concise scientific biography.

As the title indicates, the relations between mathematics and physics form the thread connecting all this very varied matter. This is not the place to discuss M. Picard's views; but so much has now been written round this theme that we wish that some acute but painstaking person would endeavour to reduce it all to order, and explain to us what is common to all writers and what is still in dispute. Perhaps the task is impossible; the question is really that of the relations between two types of mind, and may be eternally inexplicable; it may be that the views of M. Picard, or of any other, if reflected in any other mind, would cease to be his views. But unless some such co-ordination is possible, the deep learning and keen insight displayed in these discussions must be largely wasted.

### Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

#### The Effect of the Earth's Rotation on the Velocity of Light.

PROF. MICHELSON has now relieved his Newtonian mind by carrying through his heroic experiment, reported in NATURE of April 18, p. 566. He finds, as he anticipated, that the ether around the earth is not disturbed into a whirl by the earth's rotation. This was to be expected, has seemed in fact inevitable, if the ether is the universal medium in which matter subsists as independent small atomic structures, each with its field of main activity purely local, in the manner vividly illustrated in less abstract days by the vortex atoms of Lord Kelvin. Like the aberration of light, the effect under notice is of the first order ( $v/c$ ), and so is conspicuous far above the very refined modern relativity so called, which is founded on second order ( $v^2/c^2$ ) experiments and theory.

To those who still cherish the belief, as above expressed, that the result arises naturally from actual rotation of the earth relative to the surrounding ether, and so are not reduced to ascribing it to occult mutual influence of the universe as a whole (for the effect revealed, whether it is called rotation of the earth or not, must be relative to something other than a surrounding vacuity), a main interest of this *tour de force* will perhaps lie in a different direction. The astronomical aberration of light was discovered and elucidated by Bradley, while Newton was still living, on a basis which required the ether to be stagnant—or at most to move irrotationally near the earth as Stokes indicated. Until recently, perhaps still, this criterion has remained uncertain to about one-fifth of one per cent., for the constant of aberration remained unsettled, and so might be a varying quantity, within that degree. Prof. Michelson and Prof. Gale seem to have here missed, not very widely, a full decision on this fundamental astronomical datum by a single purely terrestrial experiment, for their margin of uncertainty as now announced appears to be only twelve times that of the most refined determinations of astronomy. (Some of the recorded deviations from the mean are, however, large, with preponderance in one direction, so as to suggest weighting which would improve the result.)

The finite velocity of light, after resting for two centuries on indirect, but of course adequate, celestial evidence, was brought down to earth by direct measures by Fizeau, Foucault, Newcomb, and Michelson. It seems noteworthy that the present experiment has just missed, by no great margin, fixing the distance of the sun, the base line of astronomy, by measurements purely optical, free from need of confirmation by other determinations whether directly parallactic or indirect results of gravitational astronomy

JOSEPH LARMOR.

Cambridge, April 19.

THE experiments of Profs. Michelson and Gale, described in NATURE of April 18, are of such fundamental consequence that it is important to express their physical implications in the simplest possible way.

Prof. Michelson's original mathematical discussion of the experiment (*Phil. Mag.* 8 (1904), p. 716) appears to be inadequate; it wrongly supposes the path of a

ray of light relative to rotating axes to be a straight line. The essential features of the problem are all reproduced if the ray of light is imagined, instead of describing a rectangle as in the actual experiment, to describe a circle, or rather a many-sided polygon inscribed in a circle. Let  $a$  be the radius and  $A$  the area of this circle. To a first approximation, the time required for a beam of light to get round the circle in either direction is  $2\pi a/c$ , where  $c$  is the standard velocity of light. On account of the earth's rotation, the material circle rotates in space with an angular velocity  $\omega \sin \theta$ . Thus while the beams of light are moving once round the circle, the mirror which constitutes both starting-point and winning-post moves round the circle a distance  $2\pi a^2 \omega \sin \theta / c$  to meet the ray which is travelling in the clockwise direction, thereby lengthening the course for the anti-clockwise ray by an equal amount. The difference of path for the two rays is accordingly twice this amount, or  $4A\omega \sin \theta / c$ , and this formula can be shown to be equally valid for the rectangular path of the actual experiment.

If the velocity of each ray in space is precisely  $c$ , the phase-difference between the two rays (in complete fringes) will be

$$\Delta = \frac{4A\omega \sin \theta}{\lambda c},$$

which is the formula used by Michelson and Gale, and verified by their experiments. If the two velocities are equal to one another, although not precisely equal to  $c$ , the formula holds as an approximation. If the velocities are unequal, the formula fails.

Freed of all hypotheses about the ether, the experiments appear to show that the velocity of light in space is the same (to within one part in  $10^{11}$ ) whether the light travels in the direction of the earth's rotation or in the contrary direction. This is in accordance with the theory of relativity. Thus the experiments do not affect the position of this theory, although a contrary result would have destroyed the theory. The experiments show either that there is no ether or else that, if there is an ether, the earth does not drag this ether into motion by its rotation.

The original Michelson-Morley experiment admits of three separate interpretations: (a) there is no ether; (b) there is an ether which accompanies the earth in its motion; (c) there is an ether which is at rest in space, bodies moving through it undergoing contraction in accordance with the Lorentz-Fitzgerald formula. The present experiments dispose of interpretation (b), which, however, is generally supposed to be adequately disposed of already by the phenomenon of astronomical aberration. Interpretations (a) and (c) remain open, and the experiments do not appear to provide the means of deciding between them.

J. H. JEANS.

#### The Dinosaur Region in Tanganyika Territory.

MR. C. W. HOBLEY's interesting article in NATURE of April 18 (p. 573) ought to carry conviction as to the importance of the small collecting expedition which has been organised by the Trustees of the British Museum. In a short note published in this journal a year ago (March 8, 1924, p. 361) Gigantosaurus (or Tornieria), the main object of this expedition, was referred to in a manner which seems to be almost playful. The animal which is described as having "more slender limbs" than the American Diplodocus is a giant of stupendous size, possessing a humerus seven feet long, in its massiveness by no means suggestive of a creature of graceful or slender build. Without further qualification the description scarcely does justice to this wonderful animal.

Size is in fact a consideration of very practical importance. In the present instance everything must be done on a large scale—the excavation of the bones, their treatment on the spot, their transport to the coast and their freight to London. It is obvious that the work must be expensive, and I venture to hope that practical assistance will be given to the Museum, to enable it to continue and to make more complete the work already in progress. The excavation of the site can be carried on, until the end of the present year at least, by means of funds in the hands of the Trustees. It can only be done, however, on a very modest scale, by restricting the number of workers, and their remuneration, to a minimum. Even with this restricted programme it cannot be continued long enough to derive all the results obtainable from the bones which are lying on the surface, or close beneath it, in great profusion. What variety of life is represented by the fossils is at present uncertain, but the consignment just received from Mr. W. E. Cutler, who is in charge, indicates that the bones are in an excellent state of preservation and that they are by no means all of one kind. The extent of the Dinosaurian fauna of Africa has yet to be explored, and it must be remembered that this Continent has constantly yielded fresh surprises in animal life.

The study of African dinosaurs is almost at its commencement, but we know that the material is there, ready to be picked up by any one provided with a sufficiently long purse. Certain friends of the Museum have already sent generous contributions, by means of which a fund of some hundreds of pounds has been raised. It is a very welcome addition to our resources, and it will materially help us to carry out the work more satisfactorily than would otherwise have been possible. It falls far short, however, of our actual requirements, and I appeal for a material enlargement of the fund. Contributions, large or small, may be sent to me at the Natural History Museum, marked "Tanganyika Fund."

SIDNEY F. HARMER.

British Museum (Natural History),  
Cromwell Road, S.W.5.

#### Method of Measuring Deep Sea Tides.

IN a letter to NATURE of April 4 under this heading Prof. R. W. Wood suggests the use of a subsurface buoy as an "artificial island" for supporting recording tidal gauges, in order to study the tidal rise and fall in the open sea. Many readers of NATURE are, of course, aware that a similar contrivance was worked out by Swedish oceanographers more than fifteen years ago, and has been repeatedly used with very satisfactory results, in order to take continuous records of the subsurface currents from points in the open sea off the coasts of Sweden.

A large buoy of half a cubic metre capacity with a net buoyancy of some 300 kgm. is kept submerged at a depth of from five to ten metres below the surface (the depth being fixed so as not to interfere with shipping) by double anchorage, the cables diverging by about 120°. From the buoy one or two recording current meters of the Pettersson type are suspended at the desired depth, taking observations of the direction and the velocity of the current every thirtieth minute for a fortnight without recharging. As many as three such "Ekman buoys" have been used simultaneously at different localities, while the research vessel was otherwise engaged. As the point of suspension, that is, the buoy, is practically without any proper motion, the observations thus obtained are perfectly free from the errors inherent in current observations taken from ships swinging at anchor,

and thus the tidal currents as well as the residual current can be computed correctly. A large number of such current observations which have been taken in the course of the last few years are at present being worked up for publication.

For some time it has been the intention of the Swedish hydrographers to use the same arrangement for establishing a kind of submarine hydrographic station in the open sea, the water temperature being taken by thermographs, the horizontal movements by recording current metres, and the vertical movements by means of balanced submarine floats rising and falling with the boundary of the layer in which they float, and recording its vertical movements by means of pressure-gauges, such as have already been used at our coastal stations. By means of two such buoys marked with flag-staffs showing above the surface and anchored some distance apart in the open sea, a base-line can be obtained serving to define the movements of large subsurface drifters marked with small surface buoys, and thus one should be able to follow directly the movements of the water during a tidal period. The rise and fall of the water level should at the same time be studied by means of recording pressure-gauges, and the currents, as usual, by our registering current meters. By means of one or two such mid-sea tidal stations anchored at representative points, and supplemented by continuous observations from lightships, the intricate problems related to the tidal wave in the North Sea might be brought considerably nearer their solution. This scheme, which has been on the Swedish programme for some time, can obviously be carried out only by the co-ordinated efforts of the nations interested.

Regarding the use of the submerged buoy for observations over great depths, no experience has so far been gained, the greatest depths at which it has hitherto been used being about 100 metres. At depths much greater than a few hundred metres, the weight of the anchors and wire-rope required would probably be a serious obstacle. For particulars of the apparatus I may refer to *Svenska Hydrografisk-Biologiska Kommissionens Skrifter*, 5, and *Quarterly Journal of the Royal Meteorological Society*, June 1914.

HANS PETTERSSON.

Oceanografiska Institutionen,  
Goteborgs Högskola.

#### An Amphoteric Substance in the Radula of the Whelk (*Buccinum undatum*).

THE experiments of J. Loeb ("Proteins and the Theory of Colloidal Behavior," New York, 1922) have shown that the iso-electric point of amphoteric substances is readily determined by staining them with basic or acidic ions or dyes at known hydrogen-ion concentrations. The method has since been applied for the determination of the iso-electric point of the mycelium of *Rhizopus* (Robbins, W. J., 1924, *Journ. Gen. Physiol.*, 6, 259) and of bacteria (Stearn, E. W., and Stearn, A. E., 1924, *Journ. Bacteriol.*, 9, 463) by staining with dyes.

The radula of *Buccinum* appears to consist of two zones, a young newly formed part (chitin A) and an older part (chitin B). Passing along the radula, the change from chitin A to chitin B is sudden, though a small portion of chitin A persists in the base of each tooth throughout. The reactions of A and B differ entirely and will be fully dealt with in a forthcoming paper by one of us (T. H. R.).

Radulae were soaked in buffer solutions of known  $p_H$  to which had been added a few drops of a solution

containing one of the following ions,  $\text{Ag}^+$ ,  $\text{Cu}^{++}$ ,  $\text{CNS}'$ , and  $\text{Fe}(\text{CN})_6^{4-}$ . The radulae were then washed so that the ions were only retained where they had combined with the chitin. The presence of the combined ions was readily detected by the usual reagents, the silver going black on development with hydroquinone, the copper being converted into the brown ferrocyanide by  $\text{K}_4\text{Fe}(\text{CN})_6$ , and the  $\text{CNS}'$  and  $\text{Fe}(\text{CN})_6^{4-}$  giving the usual red and blue colours respectively with ferric chloride.

Since an amphoteric substance is basic on the acid side of the iso-electric point and acidic on the alkaline side, the basic copper and silver ions should combine with it only if the solution is more alkaline than the iso-electric point. Conversely, the acid ions  $\text{CNS}'$  and  $\text{Fe}(\text{CN})_6^{4-}$  will only combine with the substance on the acid side of its iso-electric point.

The results of a typical experiment are shown in the table.

Ion present	pH of Solution.					
	1.0	2.2	2.6	3.0	3.6	
$\text{Ag}^+$	All deep black					Chitin A
	White	Faint grey	Grey	Black	Deep black	" B
$\text{Fe}(\text{CN})_6^{4-}$	All deep blue					Chitin A
	Deep blue	Blue	Pale blue	White	White	" B

Chitin A and chitin B are seen to be very different. Whereas chitin A combines with both anions and cations irrespective of the pH, chitin B appears to be an amphoteric substance with an iso-electric point at about pH 2.6: in a more acid solution it is basic, and combines with the ferrocyanide anion but cannot combine with the silver cation; in a more alkaline solution it is acidic, and combines with the silver cation but cannot with the ferrocyanide anion.

Identical results were obtained with fresh radulae and with those which had been previously boiled in strong potash to remove adhering tissue.

From these experiments, the change undergone by chitin A on conversion into chitin B appears to be profound.

C. F. A. PANTIN.

T. HOWARD ROGERS.

The Marine Biological Laboratory,  
The Hoe, Plymouth,  
March 21.

### Ball Lightning Phenomena.

At dawn on the morning of the last day in 1924 there occurred in the neighbourhood of Aberystwyth, in Cardiganshire, a thunderstorm of short duration but of unusual violence, and people were alarmed at what they saw and heard. News reached me that a "ball of fire" had been seen during that storm at a village called New Cross, some 4 miles south-east of Aberystwyth. On hearing this I went over to interview the observers. I found three at once; Mr. and Mrs. Pugh and Mr. Morgan at the inn. Mr. Pugh's attention was first attracted by a terrific noise. On looking out his bedroom window what he saw he described as "falling lumps of fiery material" and as a "scattering of fire as from a centre" about level with the ground, and, apparently, not far from the house. The house shook, and the effect was alarming. The three did not venture out for half an hour after the event. At Penywern, a farm-house near by, a window pane shown to me was cracked by the explosion.

I found another observer, Mr. Davies. He said that whilst dressing he looked out to see what kind of weather it was, and whilst at the window saw a brilliant ball of fire at some height from the ground

in a direction  $30^\circ$  or  $40^\circ$  from the horizon. The "ball" was more or less round but with luminous protuberances. The direction in azimuth tallied with that of Pugh. It is likely, therefore, that Davies saw the same object as was seen by Pugh but at an earlier epoch. Unfortunately Davies withdrew his gaze, involuntarily, owing to the startling brightness and strangeness of the vision and, consequently, saw no more. Had he continued observing the story might have been complete.

Whilst at New Cross I was told that strange things had been seen by Mr. Edwards, of Glanrhos, four and a half miles away in direct line. I proceeded there, and Mr. Edwards very kindly and readily described all he had seen and experienced. Many things happened on the premises, but the following is the most important. Mr. Edwards was in the barn when the crash happened. He was thrown bodily backward but not in any way damaged. On looking out he saw what appeared to be three distinct luminous masses dropping on the manure heap in the yard. This was followed by a column of smoke or vapour rising from the place of impact. This occurred during a shower of hail. The hailstones were unusually large—half an inch or even an inch across, and of very irregular shape.

In these accounts there appears to be one point of interest common to both. Mr. Edwards saw the luminous volumes *after* he had been thrown. At the instant of being thrown he was in the act of bending to lift into a vessel some chaffed material that was lying on the floor of the barn, and had his eyes fixed on the job. Similarly Mr. Pugh also, he *heard the crash first* and on looking out saw the luminous objects. There was an interval, therefore, between hearing and seeing in both cases which cannot be explained on the assumption that what occurred was an ordinary single electric discharge. Either there must have been at least two discharges with an interval between, or something happened in a much more leisurely manner than an ordinary electric discharge. Are these luminous objects likely to be identical with the ball lightning? It is not suggested in the account given that the luminous objects were solid bodies.

BEN DAVIES.

Llys Teg,  
Port-rhyd-fendigaid,  
Cardiganshire.

### Sound Production by Insects.

UNDER this heading in NATURE of March 21, p. 437, there was a short notice of a paper published by Dr. F. E. Lutz in the Bulletin of the American Museum of Natural History, vol. 50, p. 333, 1924. I have not been able to avail myself of the original paper, but the review brings forward several interesting points. The view expressed is: that our present knowledge does not furnish good grounds for believing that the few cases in which we hear insect sounds are exceptions to a rule, namely, that insects do not communicate by that means; that in the case of Orthoptera the presence of extreme specialisations for making sounds, accompanied by what appear to be definite ears, are grounds for thinking that here communications may be carried out by sound; but the fact that termites, *which are not known to stridulate*, have the same sort of ear as that possessed by crickets and long-horned grasshoppers, weakens the argument somewhat.

I should like to direct attention to a recent paper which I published in the Trans. Ent. Soc. Lond., Parts III. and IV., p. 492, 1924, on the habits of Brazilian insects. In the course of this paper I mentioned that I had observed termite soldiers making

noises by two different means, (1) by vibrating their bodies up and down and hitting their hard "chins" against the ground (*Cornitermes similis*, Hag.), (2) by sharply crossing one mandible over the other (*Mirotermes fur*, Silv.). In some species the mandibles have even been modified for the purpose and are asymmetrical. So far as my observations went, the termites only made a noise when there was danger about, such as when I broke open their nests, and then each *Cornitermes* soldier would tap violently for perhaps half a minute, pause as though listening to the tappings of its neighbours, and then recommence.

Other insects, for example various beetles, will stridulate when attacked. Whether this has the effect of frightening its enemies is difficult to prove. Others again, for example various bugs, only possess functional stridulating organs in the male sex. I believe I am right when I say that some of these have been heard in action when the sexes have been placed together. In spiders a parallel state of affairs is found. I have myself made some of those which possess stridulating organs in both sexes (Aviculariidae) produce sounds by teasing them and putting them on the defensive, while the only occasion on which I have observed the other type stridulating, in which the organs are present in the male alone (Theridiidae), is when he is in course of his courtship.

No conclusive experiments have been performed to show that spiders can hear. In the first case, where the spider is merely trying to frighten its enemies, this is not a necessary supposition, but, if the sound-producing organs are to be of any value in courtship, the female must possess some kind of ears, even if they consist merely of a few hairs which vibrate in such a way that she can recognise his presence. Are we to explain the facts to our satisfaction by a series of strange coincidences, or by admitting our inability to discover the organs of hearing in insects and spiders up to the present time?

One has got the impression that Dr. Lutz would like to explain the origin of stridulating organs by the mutational theory. Something of a Lamarckian nature would probably fit the facts more easily.

W. S. BRISTOWE.

Winnington Hall, Northwich, Cheshire,  
March 23.

#### A Method of Determining the Frequency of a Tuning Fork.

In an experiment performed in this laboratory on the determination of surface tensions of liquids by the method of ripples, a tuning fork, provided with a dipper and slits on the two prongs, was used to produce the ripples as well as to illuminate the surface of the liquid by intermittent light, obtained by passing a narrow beam of sunlight through these slits and reflecting it on the surface by a plain mirror. It thus became necessary to determine accurately the frequency of the tuning fork with all its encumbrances. Evidently the ordinary graphic method could not be used without introducing more complications and thus altering the frequency, and means were not available of utilising the stroboscopic method. The frequency was, therefore, determined in terms of the length, or the time of vibration, of a simple pendulum hung in front of the slits of the prongs. The light, after passing the two prong slits, passed immediately above the bob of the pendulum, illuminating a small cross which connected the bob to the suspending thread. The light ultimately fell on a drum round which could be wrapped an ordinary photographic film.

On setting the prongs and the pendulum in oscillation, and revolving the drum and at the same

time moving it at right angles to the path of the light, a record was obtained on the film consisting of alternate patches of light and darkness, on which, at regular intervals, was impressed the shadow of the above-mentioned cross. The frequency of the fork could thus be determined by counting and estimating or measuring the whole and fractional number of bands between two successive impressions of the cross. In the absence of any other mechanical devices, the drum can be set in rapid revolution by the hand and moved across the path of the light, again with the hand. The fork has of course to be electrically maintained.

It may be worth while to direct attention to the fact that in all previous experiments on the determinations of surface tensions by the method of ripples, two forks have been used, one for producing the ripples and the other for illuminating the disturbed surface intermittently, the forks being driven electrically in the usual way so that the vibrations of the two were synchronous. In the present experiment, only one fork was used for producing the ripples as well as making them visible. The values obtained of the surface tensions of water and dilute salt solutions were consistent among themselves and agreed with those given in the Tables, etc. The experiment was carried out by Mr. Jai Kishen, one of my M Sc. students of last year. J. B. SETH.

Physics Laboratory,  
Government College, Lahore,  
February 26.

#### Change of Linkage in Poultry with Age.

Two dominant sex-linked Mendelian factors in the domestic fowl are known from the work of W. E. Agar (*Journ. Genet.*, vol. 14, pp. 265-272, 1924), J. B. S. Haldane (*Sci.*, vol. 54, p. 663, 1921), and G. S. Serebrovsky (*Amer. Nat.*, vol. 56, p. 571-572, 1922), to exhibit partial linkage during spermatogenesis, as was to be expected if both are carried by the same chromosome. One of these, B, causes barring of the feathers; the other, S, causes silver as opposed to gold hackles. We have synthesised five cocks of composition, BS bs, *i.e.*, receiving both these factors from one parent only, and mated them with bs hens. Thus each of the four possible types of spermatozoon gave rise to a different type of chick. So far 648 chicks have been counted. We find that the linkage between B and S becomes progressively weaker with the age of the cocks. In their first, second, and third breeding years respectively these have given  $22.9 \pm 1.4$  per cent.,  $36.9 \pm 2.9$  per cent., and  $47.6 \pm 3.6$  per cent. of cross-overs. Thus by the third year linkage has practically disappeared.

So far C. B. Bridges (*Journ. Exp. Zool.*, vol. 19, pp. 1-19, 1915) has found a slight increase of crossing-over with age in one chromosome only of *Drosophila*, J. S. Huxley (*Brit. Journ. Exp. Biol.*, vol. 1, pp. 29-96, 1924) a decrease with age in *Gammarus*, and Castle (Castle, W. E., and Wachter, W. L., *Genetics*, vol. 9, pp. 1-12, 1924) no change in mice and rats. The variations recorded in plants may be due to temperature and other causes besides age. The change observed by us might be due to diminished rigidity of the chromosomes, increase of the forces tending to break them, or other causes. But it is of interest as pointing to pre-senile changes in the behaviour of the dividing nucleus, and as being the clearest case so far recorded in vertebrates of a change with age of the "germ-plasm" of an individual. The experiment is being continued, but will probably require another two years for completion.

J. B. S. HALDANE.  
F. A. E. CREW.

The Biological Action of Light.<sup>1</sup>

By Prof. LEONARD HILL, F.R.S.

From the National Institute for Medical Research.

WHILE the heat spectrum, including infra-red, visible and ultra-violet rays, extends from a wave-length of some 60,000  $\mu\mu$ <sup>2</sup> to one of 100  $\mu\mu$ , beyond the outer dark heat rays are the Hertzian waves used in radio with wave-lengths extending to a thousand metres or more. The inner dark heat rays merge into the visible, which are of wave-lengths from 700  $\mu\mu$  (red) to 400  $\mu\mu$  (violet). Beyond the visible lie the invisible ultra-violet rays with wave-length from 400  $\mu\mu$  to 100  $\mu\mu$ , and beyond these come the soft X-rays and then the hard X-rays and the  $\gamma$  rays of radium with wave-lengths so short as 0.01  $\mu\mu$ .

The body of a man is surrounded with a horny layer of skin beneath which lies the living cells of the epidermis in thin layers and myriad in number. Beneath them circulates the blood through close woven networks of capillaries, in streams some 0.01 mm. thick. The epidermis reflects and scatters rays which fall upon it, but some part of the visible rays penetrate and are absorbed by the blood beneath, warming it. The dark heat rays, on the other hand, absorbed mostly by the epidermis, warm it more than the blood in the dermis. Set as windows in an almost impenetrable skin, the eyes have been evolved with extreme sensitivity to a narrow portion of the spectrum, namely, the visible rays. To Hertzian waves we are insensitive; their energy has to be converted into sound and heard. Likewise we cannot feel ultra-violet, X- or  $\gamma$  rays: a latent period of two or three weeks follows exposure to X- or  $\gamma$  rays before an erythema of the skin and irritation results. A latent period also follows exposure to ultra-violet rays, but one limited to hours. While the hard X-rays and  $\gamma$  rays and secondary rays started by these penetrate in part to deep tissues, the active ultra-violet rays are wholly absorbed by the epidermis and exert their effect there.

Sonne found that if dark heat rays are brought to bear on the skin up to the just endurable sensation of burning, the temperature just beneath the skin will be raised to about 43° C. On the other hand, if visible rays alone are concentrated on the skin to the just bearable degree, the temperature just beneath the skin will be raised even to 47° C. This result, confirmed by Argyll Campbell and L. Hill, is due to the greater absorption of dark heat by the surface layer of the skin and a deeper penetration of the visible rays. Sonne ascribes heliotherapy to the local heating effect of the visible rays and has tried to find evidence that such local heating of the blood increases specific antibodies of the body, e.g. the diphtheria antitoxic content of the serum. However, P. Hartley has reinvestigated this matter with great refinement and accuracy of method, both in regard to the diphtheria antitoxin content of the serum and the agglutinin content of the serum against *B. typhosus*, and finds that light baths have not the least effect on such a specific immunity. The baths have power, on the other hand, to increase the general resistance of the body to infection, as was shown by L. Colebrook, A. Eidinow, and L. Hill, who found that a

light bath intense enough to produce erythema put up the hæmo-bactericidal power of the blood as tested *in vitro*. Blood which before the bath killed say 80 per cent. of staphylococci mixed with it, two hours after a light bath killed 100 per cent. Such an effect followed no less when a *lasting* erythema was produced by exposure to heat or a mustard poultice.

In the case of the light bath the relative activity of visible and ultra-violet rays is proved in the following way. If an arclight with "white flame" carbon poles (direct current and about 2500 kilowatts) is focussed sharply through a quartz lens on to the arm, an unendurable burning sensation results almost at once. If the arm is immersed in a quartz vessel full of cold water and the experiment is repeated, no burning sensation results, but if the exposure is continued for five minutes, erythema develops some hours later at the exposed spot, and this may advance even to a blister, to be followed by a long, lasting, brown pigmentation. Repeating the last experiment with a quartz screen filled with 3 per cent. quinine solution interposed between the arc and the arm, all ultra-violet rays shorter than 330  $\mu\mu$  are thus cut out, as can be shown by the quartz spectrograph. In this case no erythema results even after over an hour's exposure. The visible rays then, apart from their heating effects, have no effect on the skin. The ultra-violet rays, acting on the cooled skin, have, on the other hand, a profound effect.

Using a quartz spectrocope and a blackened thermopile for measuring the energy of various parts of the ultra-violet spectrum, it was found by Hausser and Vahle that the maximal power for producing erythema of the skin was with the wave-lengths 300-290  $\mu\mu$ , just the region which comes through with the high sun on clear days. Little effect was given by rays 313  $\mu\mu$  and 250  $\mu\mu$ . A screen of uric acid (1 in 40,000 solution) in a quartz container absorbs rays shorter than 306  $\mu\mu$  (Dhéré). The mercury vapour lamp through this screen produces no erythema even after giving six times the erythema dose for the unscreened lamp. Lines 275 and 257  $\mu\mu$  of the cadmium spark spectrum produce erythema, but not line 232  $\mu\mu$ . Such short rays do not penetrate the horny skin but actively kill infusoria.<sup>3</sup>

How slight is the penetrating power of the ultra-violet rays is shown by interposing in place of the quinine solution a thin film of the horny layer of the skin taken off a blister, or the mesentery of a rabbit. Such a film protects the skin no less than the solution of quinine.

The active ultra-violet rays penetrate to the deeper epidermic cells but no farther. Among these cells there takes place multiplication and growth, formation of pigment and transition into the horny material which is pushed outwards by the growth of cells within. In these cells the ultra-violet rays provoke changes which we may assume are similar to those which have been photographed in living anthrax bacilli by Mr. J. E. Barnard, using a microscope with quartz lenses and a band of ultra-violet rays from the cadmium spark. Under the ordinary microscope they have been observed

<sup>1</sup> Substance of two lectures given at the Royal Institution on March 12 and 19.

<sup>2</sup>  $\mu\mu = 0.00001$  mm.

<sup>3</sup> I am indebted to Messrs. J. E. Barnard and J. Smiles for the use of the spark.

by A. Eidinow and L. Hill on infusoria. An increasing aggregation of particles takes place in the bioplasm; in the case of infusoria this leads to cessation of movement, death, rupture, and setting free of the particles. So, too, the surface film of egg white exposed in a quartz chamber is coagulated by ultra-violet rays. Positive particles are dispersed and negative ones aggregated (Clark).

These rays displace electrons in atoms according to present physical theory and so alter the charge of the particles, some of which are to be seen in bioplasm by dark ground illumination and high microscopic magnification in active Brownian movement. This leads to aggregation started by the displacement of electrons in the atoms. Chemical change in molecular structure ensuing in the epidermal cells after a latent period, reaches such an irritative nature as to lead to dilatation of the subcutaneous blood vessels, exudation of lymph, increase of lymphocytes, and rise in the hæmobactericidal power of the blood. In cases of rickets the abnormally low inorganic phosphorus content of the blood which is significant of this condition is put up also in a striking way. Subsequent to these reactions there results desquamation, due to death of some epidermal cells followed by pigmentation. The pigment melanin is laid down as granules in that layer of living cells which lies close underneath the horny layer. Melanin is stated to be formed by the action of an oxydase in the deeper epidermic cells, as may be seen in the fresh sections of skin (cut frozen) when radiated and wet with a solution of dioxyphenylalanin; this substance is said to be the specific precursor (Bloch). The closely allied compound, tyrosin, is said to diminish in amount in the blood at the time when melanin is being formed in the skin after a light bath.

Ultra-violet rays act more quickly on warm than on cold skin. Tested on infusoria the coefficient for temperature (for a rise from  $10^{\circ}\text{C.}$  to  $20^{\circ}\text{C.}$ ) is about 2.3 (A. Eidinow and L. Hill); for the frog's mesentery it is less, about 1.2 (Argyll Campbell and L. Hill). While heat of the sun may aggravate a sun burn, it is not a necessary adjuvant. Ultra-violet radiation can intensely burn the cooled skin; it is well known that glacier sun-burns may be very severe. Dewar killed microbes with ultra-violet rays at the temperature of liquid air.

The power behind the sun was worshipped by the heretic pharaoh, Akhnaton, and modern science leads us back to veneration of this power. The imagination tries to think of the infinitely intricate energy complex which goes to form a living cell, of electrons being displaced in atoms by ultra-violet rays, of molecular movement enhanced by heat rays, of radiation provoking reactions which manifest themselves as life, the spirit of man ensuing in the evolution of energy transformations.

The law holds that absorption of rays precedes action. Rays which pass through a cell have no action upon it at all. The skin screens itself from excessive light by its horny layer and by pigment. Pigment by absorbing visible and ultra-violet rays screens the deeper cells and blood. It absorbs dark heat rays and converts visible rays into heat, and this heat, stimulating the nerve endings in the skin, may reflexly lessen body heat production while provoking sweating and dilatation of cutaneous blood vessels.

Melanin is a screen, not a sensitiser, transforming light into heat. It is present in a fine particulate form

and scatters and diffusely reflects rays. The spectrograph shows that melanin in fine suspension and thin layers screens off and greatly weakens but does not wholly absorb the ultra-violet spectrum. This is in sharp contrast to a 3 per cent. solution of quinine which in an equally thin layer wholly absorbs rays shorter than  $330\text{ }\mu\mu$ . A layer of sweat wetting the skin helps to reflect light, while a layer of evaporating moisture surrounding the skin helps to absorb heat rays. The pigmented naked body with sweating skin is thus favourable to the cooling of the native in the tropics, while clothing retards heat loss of the white man.

By local concentration of an arc light on a rabbit's head, it is easy to heat its fur up to  $150^{\circ}\text{F.}$  and its brain even to  $107^{\circ}\text{F.}$  while with the body in the shade the rectum is only  $101^{\circ}\text{F.}$  (Argyll Campbell and L. Hill). Pith helmets prevent local heating of the head and sunstroke in the tropics. There is rarely any danger of sunstroke in Great Britain. The sun is powerful enough only on few summer days, and bare heads offer no risks except on these rare occasions. Heatstroke from overheating of the whole body due to exhaustion of sweating in warm stagnant air is much more common—overclothed as we are for withstanding hot weather.

Downes and Blunt (1877) proved that the bactericidal action of light was due to ultra-violet rays, and much has been made of this. It has been claimed recently by Wiesner that the infra-red rays, apart from their heating effect, have a bactericidal action, but this is not so (A. Eidinow and L. Hill). The only rays which kill, apart from any lethal heating effect, are the ultra-violet rays. The bactericidal power of these rays is not nearly so important as has been thought, for the rays can only kill the surface bacteria. They cannot penetrate into filth any more than through the epidermis. In their curative effect on lupus these rays act, not by directly killing the bacilli, but by increasing the immunising powers of the tissues. This is so, even when the rays are focussed as in the local Finsen light treatment. Nodules so treated, when injected into guinea-pigs produce tuberculosis.

Mr. J. E. Barnard, by photographs taken with ultra-violet rays and a quartz-lensed microscope, has shown structures hitherto unrevealed in living yeasts, bacteria, and blood cells. This is due to the selective absorption by the outer membrane, the nucleus, and certain other granules in the cells. Infusoria vary in their susceptibility to the lethal effect of ultra-violet rays, and this probably bears a relation to the age, nutritional state, and absorptive particles within them. The lethal power on cells increases with shortening of the ultra-violet rays: for example, using the cadmium spark, a 20-minute exposure sufficed to kill infusoria placed in the  $275\text{ }\mu\mu$  band, and a 3-minute exposure in the  $232\text{ }\mu\mu$  band. The penetration of the shorter rays, however, is far less, and these, therefore, have no action on the skin. Thus, as stated above, while bands 275 and  $257\text{ }\mu\mu$  of the cadmium spark produce erythema of the skin, the intense  $232\text{ }\mu\mu$  band has no effect.

In the case of the very short rays, Mr. J. E. Barnard finds one anthrax bacillus screens another lying beneath it. With rays of weak intensity, processes of repair may keep pace with injury, and no effect be produced in living cells. A screen which allows ultra-violet rays to pass so as to give an excellent spectrum, as photo-

graphically recorded by means of the quartz spectrograph, may be found to reduce biological action very greatly, as is shown when the lethal power of the screened rays is tested against that of the unscreened on infusoria or the skin. The photographic method is so exceedingly sensitive that deductions cannot safely be drawn from it alone.

It is claimed that immunity is set up in the epidermis by one exposure to a subsequent one, and this long before pigment is formed (Perthes). Thus if an area of the skin be exposed for five minutes and again for five minutes some hours later, and a second area be given 10 minutes exposure all at one time, the erythema will be much more marked in the second area. Choosing a small dose, a second one given a few hours later increases erythema and soreness. Maximal erythema, of course, cannot be further increased by a second dose, but this seems to be true for soreness also. The immunity is no doubt due to coagulation of the outer layer of living cells, whence comes peeling. When pigmentation is still well marked weeks after an exposure, susceptibility of the epidermis may be shown to have returned by the erythema following a further dose of ultra-violet rays.

To measure the therapeutic action of the ultra-violet rays we can use the lethal dose for infusoria contained in a quartz cell at 15-20° C., or the erythema-producing dose for the skin of the average white arm, or the rate of bleaching of a standard solution of acetone and methylene blue. The last has been standardised against the two former, and each degree on the scale is twice to four times that required to produce a moderate erythema. (A. Webster, L. Hill, and A. Eidinow.) The acetone blue solution is exposed in a quartz tube of standard diameter, and after exposure the degree of bleaching determined by comparison with a set of blue tubes of depths of tint 10 to 3. The acetone solution absorbs the ultra-violet rays shorter than 360  $\mu\mu$ , and the chemical reaction set up in it bleaches the blue. Observations have been taken daily with full exposure to sun and sky at various places and show the intensity of ultra-violet radiation in clean air and the effect of smoke and pollution. During a fine summer day the quartz tube may have to be changed two or three times in the day, and the highest total reading last summer at Peppard, Oxon, equalled 23. In the Alps a reading of 41 was obtained in one day. In dull cloudy weather of winter the reading may be 1 or 2 and in smoke polluted towns 0.

Using in addition a clock to keep moving the quartz tube together with a small screen to shade it from the sun but not from the sky except that immediately round the sun, we have found that the total ultra-violet radiation from the sky is far more than from the direct sun. Dorno at Davos showed that this was so using a cadmium photo-electric cell for recording the ultra-violet radiation. Even with the sun at its zenith, the ultra-violet radiation from it is only about 90 per cent. of that from the blue sky. With the low sun, the sky yields far the more.

Smoke pollution robs us of half or more of the ultra-violet rays. While seeking to abolish this evil, we require to make the loss good by the use of artificial sunlight baths. Screened as he is by window-glass, clothes, fog, and smoke, the citizen is cut off from ultra-violet rays almost wholly in winter, and in consequence his general health and resistance to disease goes down.

The evil is enhanced by indoor life spent in heated stagnant air of rooms, and by lack of open air, exercise, and by a diet deficient in vitamins. Thus the resistance to catarrhal infections, which spread in the crowded stagnant air of rooms, is lowered. Those who live open-air lives and are well fed, exposed however much they are to weather, are far less often attacked.

It has already been stated that the hæmobactericidal power of the blood (as tested *in vitro*) is put up in an animal by an exposure to ultra-violet radiation which is sufficient to produce erythema. It has also been found by A. Eidinow that if a little blood is withdrawn from an animal, irradiated by rotation in a quartz flask, and then put back again into the animal, this puts up the hæmobactericidal power, and yet the irradiated blood itself has this power actually destroyed in itself by radiation. The hæmobactericidal power depends on the corpuscles and not on the serum. In man it is naturally high, and can be put up less than in such animals as rabbits and pigs. It is known that ferments, serums, agglutinins, and the anaphylactic power of blood are alike destroyed by ultra-violet radiation.

Recent research on rickets has shown that the diseased calcification of the growing bones results from a diet deficient in antirachitic substance and lack of ultra-violet rays. If young rats are put on a diet deficient in antirachitic substance and having a minimum of salts of phosphorus, the latter is not absorbed from the gut. Either the addition of antirachitic substance in cod-liver oil or ultra-violet radiation for a few minutes a day will wholly stop rickets developing and cause a minimal amount of phosphorus in the diet to be absorbed and utilised in bone building (A. Webster). It has been proved that the antirachitic substance present in cod-liver oil is not vitamin A, and that it can be put into an inactive food by ultra-violet radiation (Hess, Steenbock). Thus, inactive linseed oil, casein, flour, and lettuce leaves can be made effective as cod-liver oil in preventing rickets, by rotating them in a quartz flask in front of the mercury vapour lamp. Water, fat, starch, sugar, mineral oil, glycerine, cannot be so activated. Oils retain their acquired antirachitic power for months. It has been claimed that "active" food substance on oxidation gives off ultra-violet rays, but this is not so. The error has arisen through the fluorescence of certain quartz screens used in the photographic tests (A. Webster). Drummond has shown that radiated cholesterol makes an extremely active antirachitic substance, and possibly in all food stuffs shown to be activated by radiation this is the activated body. Possibly radiated rats absorb this from the skin.

We have no evidence so far that radiation can endow an inactive food with the growth qualities pertaining to vitamin A. If this prove possible, the margarine makers will have found a fresh source of fortune in being able to claim that their product is made equal to butter. Rickets can be prevented by making the diet more adequate, e.g. by cod-liver oil, and also by teaching mothers the need of exposing infants' and children's bodies to the sunlight and by the use of artificial sunbaths at infant welfare centres.

Prolonged exposure to intense ultra-violet rays either of the sun or an arc light produces destruction and sloughing of the white skin. While the visible rays, beside their heating effect, have no lethal effect on the

normal living animal cell, it is easy to produce a most powerful effect from these rays by sensitisation of the cells. Many fluorescent dyes have this effect, eosin, erythrosin, etc., forming a compound with the bioplasm and so making the latter absorb and be affected by rays longer than the ultra-violet.

The most interesting sensitiser is hæmatoporphyrin, an iron-free derivative from hæmoglobin, closely allied to phyloporphyrin, a derivative of chlorophyll. Traces of porphyrin (uro- or sterco-) are present naturally in the body and may possibly give to the skin some very slight natural sensitivity to visible rays. An excess of porphyrin is present in some rare individuals endowing them with an unfortunate sensitivity which causes skin eruptions and even ulceration of extremities on exposure to bright light—a disease called *hydroa æstivalis*, which has to be met by the greatest care against their exposure to sunshine or bright daylight.

When the mesentery is exposed in a cool glass irrigation chamber to concentrated visible rays of an arc, no effect results, the ultra-violet rays being filtered off by the glass. Add now a trace of hæmatoporphyrin to the bath (1 in 10,000) and in a very few minutes stasis occurs in the blood vessels. The lymphocytes gather to form thrombi which block the vessels (Argyll Campbell and L. Hill). While pigmented animals are protected, albinos made sensitive by injection of hæmatoporphyrin die after exposure to light. Meyer Betz was daring enough to inject some hæmatoporphyrin into himself and suffered from cedema of the face and hands on exposure to light. He remained sensitive for weeks. It seemed possible that sensitisation might prove useful in light therapy, but we have obtained no evidence of this. Animals do not stand well the exposure of the shaved skin to light after even very small doses of hæmatoporphyrin have been injected. Painting patches of lupus with glycerin and eosin has been tried so as to endeavour to secure a greater local effect from light treatment, but definite evidence for this has not been found (A. Eidinow and L. Hill).

Sudden exposure to ultra-violet rays stimulates to contraction such an organ as the uterus of the guinea-pig or the stomach of a frog. The excised iris by pigment is made sensitive and contracts on exposure to visible rays. Ultra-violet rays do not pass through the cornea or lens, and when the retina is damaged by over-exposure to an arc light or to sun (as in viewing an eclipse without smoked glasses) it is injured by excess of visible rays acting on its extremely sensitive substance. The specific sensitivity to different wave-lengths of the alkaline metals, sodium, potassium, etc., as shown in the photo-electric cell, is suggestive in regard to the theory of colour vision. Photo-electric effect produced by rays acting on a specific retinal substance or substances may be the first stage in the excitation of vision. Russ has claimed that the owl's eye transmits ultra-violet rays. This is not the case with the cat's eye, which has good nocturnal vision, nor with the cod's eye, a fish which swims in dim lights of somewhat deep water. Tested by putting the cornea in a band of active ultra-violet rays, using the cadmium spark, none reach a fluorescent screen placed at a window cut in the posterior part of the eye (A. Eidinow and L. Hill).

It has been suggested that there is a biological inter-

ference between infra-red, or visible rays, and ultra-violet rays. Hess found a longer daily exposure to the mercury vapour lamp necessary in order to prevent rickets in young rats (fed on a deficient diet) when a glass screen was interposed which let red and yellow rays through as well as ultra-violet, than was the case with a glass screen which only let ultra-violet rays through. The photographs of the spectra of the two screens seemed to show equality of the ultra-violet radiation, but a difference in intensity is the most probable explanation. Pech claims that both bleaching of cotton and production of erythema by ultra-violet rays is delayed by a concomitant beam of infra-red rays. Infusoria seemed to move actively longer in the light of a mercury vapour lamp when red rays were also thrown on them than without these rays. The lethal times, however, on further trial came out to be the same in the two cases, and further research on the circulation in the mesentery and on infusoria exposed to ultra-violet bands in the cadmium spark spectrum proved negative. Not the least evidence of interference with the lethal effect was found (A. Eidinow and L. Hill; Argyll Campbell and L. Hill).

Ultra-violet rays improve the growth and breeding power of fowls. Acting directly on embryos they produce monsters. The loss of breeding power in man and domestic animals such as cattle is probably due largely to indoor life. It has been established by abundant clinical experience that light treatment is excellent for surgical tuberculosis, rickets, and wounds (O. Bernhard, Rollier, Gauvain, and others). Trials recently made on many other diseases have shown that we have in artificial sun treatment a powerful stimulant to general health and in particular of the defensive mechanism of the body against chronic infections. Skin diseases such as psoriasis, ichthyosis, eczema, and boils, chronic anæmias of obscure origin, nutritional weakness and wasting in infants, chronic bronchitis and the fat flabby condition of the sedentary over-fed middle-aged person, chronic phthisis, the debility following acute infectious disease, etc., are alike greatly benefited (A. Eidinow and L. Hill; P. Hall, etc.). The open-air sanatorium and school have shown how ailing feeble children can be turned into happy vigorous ones.

A very great benefit to general health can at once be secured by the installation of arc baths in schools and public baths. If in winter all children stripped but for a loin cloth, danced to music for fifteen minutes twice a week a yard or two away from and round a powerful arc lamp, *e.g.* one taking 100 volts and 30 amperes with white flame carbons, a great improvement in vigour, alertness, and health would be obtained. It is by such means that our misty, smoky, winter climate can be immediately remedied. At the same time, we can set about to secure and use smokeless fuel and clean away the hideous smoke pollution of the air. We can also set into windows and sky-lights of schools, hospitals, and nurseries the new "vitaglass," which lets the ultra-violet rays through, and use such glass for the bulbs of incandescent tungsten filament lamps, which would then be a source of ultra-violet rays of mild intensity.

Many interesting experiments are now being carried out concerning the growth of plants and fruits with and without ultra-violet rays, and on the effect of continuous lighting.

## The Continents and the Origin of the Moon.

By Dr. R. H. RASTALL.

**DURING** the last few years there has appeared a regular flood of literature, both abstrusely technical and more or less popular, dealing with such questions as the origin and form of the earth as a whole, the stages of its history, the formation of its crust, the building of land and sea, the uprise of mountain ranges, the form and displacement of continents, the physics and mechanics of vulcanicity, and a large number of other phenomena of cosmical and geodetical nature, as well as much speculation as to the birth of the moon and its relation to the earth. These subjects have been treated from every possible point of view—astronomical, mathematical, physical, chemical, and geological. It might seem, therefore, unnecessary to add to the number of writings in this much occupied field. Nevertheless, to a geologist there seem to be certain aspects of the case that have not yet been quite sufficiently co-ordinated and considered in their mutual relations. Let this be the excuse for the following somewhat theoretical and speculative discussion.

It is not proposed to discuss here the ultimate origin of the earth or of the solar system; for our present purpose it is immaterial whether the sun and the planets have been formed by condensation of a nebula or by accretion of planetesimals; it may now be taken as axiomatic that the earth, however formed, must have passed through a stage in which it was partly or wholly fluid. This is brought out quite clearly by recent writers, such as Jeans, Eddington, and Jeffreys. The word fluid is here used advisedly, so as to avoid complications induced by the consideration of critical temperatures and pressures. This fluid mass cooled by radiation, so that at some stage a temperature gradient must have been set up; whether this gradient was regular or not is of no importance. The significant point is that the physico-chemical laws of cooling of fused material become applicable. To make the matter clear, we will consider the state of affairs at the time when the first crystalline solid phase was formed at the cooling surface; the vapour phase (the primitive atmosphere) may be disregarded.

The cooling globe then constituted a complex system of many components, and the problem arises as to the number of phases which would be present under the given conditions. In order to gain information on this point, several lines of evidence are available, especially the theoretical laws of physical chemistry, and the actual ascertainable facts of observation. Some of the last-named will be considered first.

It is obvious that the density of the earth's interior is about twice as great as that of the accessible crust: earthquake observations further indicate more or less abrupt changes of density at certain depths. In discussions on this point it is sometimes assumed, either explicitly or tacitly, that there are only *two* density zones, and no particular reason is usually given for any such stratification: it is taken for granted, but not explained. A short consideration may here be given to this part of the subject.

The high density of the earth as a whole (about 5.5) suggests a prevaillingly metallic core, although the figure is scarcely high enough to admit of a pure

metallic core, unless we assume a very thick silicate crust, to reduce the *average* density. L. H. Barnett, in a recent paper, has endeavoured to calculate the thickness of the outer crust, but his reasoning is not trustworthy, since he postulates only two zones, an assumption which is by no means proved.

At this point some purely physico-chemical considerations come in. The simple facts of metallurgical practice show that molten metal and slag possess a very limited mutual solubility, and so do sulphide and slag. Vogt has shown that at furnace temperatures the mutual solubility of slags and sulphides is of the order of 5 per cent. or less, usually much less. Hence a system of metal and silicate must split into two consolute liquid phases, of which the lighter will obviously float on the top of the heavier: the relations are exactly analogous to those of phenol and water. Therefore a metal-silicate earth would separate on cooling into two zones. But the visible crust of the earth contains a good deal of the sulphides and oxides of the heavy metals, which are also very insoluble both in metal and in slag.

On this basis V. M. Goldschmidt regards the cooling earth as a three-phase system, with a central metallic core, an intermediate sulphide-oxide zone, and an outer silicate zone, which of course would begin to solidify first.

The observational facts of geology and the results of the detailed study of the distribution of gravity combine to show that the composition of this now solidified crust is by no means uniform, even when considered from the broadest point of view. Stated in the most general terms, the continents consist of heavier material than the floors of the ocean basins, the difference amounting roughly to something like 10 per cent. The data of historical geology also show that there are far-reaching variations in the relative levels of land and sea, as indicated by transgressions and emergences. Mainly on these grounds there has been built up the doctrine of isostasy, which regards the lighter continents as floating in the heavier material now exposed on the ocean floors; we can, if we like, visualise the position as continents of granite floating in an ocean of basalt: this generalisation is not very wide of the mark, since the known sediments form only a trifling skin, and may in reality be ignored in comparison with the total thickness of the continental blocks. From the measurable freeboard of the continents and the known relative densities, it can be calculated that the depth of the floating blocks is about 100 kilometres.

Here arises an apparent contradiction. It has just been said that there is *one* outer silicate zone in the three-phase system postulated by Goldschmidt, but the facts show *two*, an acid and a basic, or a light and a heavy zone. A good deal of work has been devoted to the study of the behaviour of silicate melts during cooling under ordinary laboratory conditions, since this has an important bearing on metallurgical practice. All authorities agree that under such conditions all fused silicates form a single homogeneous solution, and there is no evidence for separation into two consolute fractions of acid and basic composition. But the conditions of the laboratory do not tell the whole story.

It is difficult to take into account the effects of pressure, obviously an important factor, and with this is closely correlated the possible influence of volatile constituents, especially water, which is known to be abundant in natural silicate melts (magmas). It has therefore been suggested that, in the presence of water, there may be a separation into mutually insoluble liquid phases. This, however, is so far pure speculation, unsupported by any experimental evidence. It is to be hoped that investigations now being carried out at the Geophysical Laboratory of the Carnegie Institution in Washington on the behaviour of silicate melts under pressure may afford some information one way or the other.

However, it appears to be unnecessary to invoke any such purely hypothetical agency. From the known facts of observation and experiment it is possible to explain the existence of a differentiation of the kind required, taking place after the first appearance of a solid crystalline phase. It may be taken as proved that in the case of silicates the density of the crystalline form is greater than that of the liquid, and hence crystals formed at an early stage at the surface will tend to sink. Since the viscosity of fused silicate of mean composition and not far above the freezing-point is fairly high, the sinking will be slow and the crystals will be melted down again. But the same high degree of viscosity will prevent ready diffusion and restoration of equilibrium; hence certain constituents, especially the heavy silicates of magnesia and iron, as well as oxides of the heavy metals, will be concentrated in the lower layers of the silicate shell, while the upper layers are relatively enriched in the light constituents, especially silica, alumina, and the alkalis, as well as in volatile elements of low density. Eventually increasing viscosity will stop this mechanical differentiation altogether, and the crust will solidify with two more or less well-marked layers. As previously stated, a difference of density of only 10 per cent. is needed to account for the observed facts. Thus the outer silicate zone is differentiated into two layers, but this, with the lower zones, does not constitute a four-phase system, since the partial heterogeneity of the outer zone is due to a failure of equilibrium. This state of affairs, however, seems to be a necessary consequence of the conditions.

According to this theory, therefore, the whole of the earth's surface should be covered by a uniform shell of rock of granitic composition, having a thickness which may be estimated roughly at 100 kilometres. But it is a geographical commonplace that the continental blocks occupy only about one-third of the earth's surface, and this ratio is not materially altered if we take, as is now usual, the 100-fathom line as the true boundary between the continents and the ocean basins.

It is difficult to conceive any purely chemical or physico-chemical cause for this peculiar space-relation of the light and heavy silicate masses. Some mechanical cause is inevitably suggested, and it becomes necessary to look about for some such cause. Once more the problem may be stated in the simplest possible language, as follows: on physico-chemical grounds the earth should have a thin uniform granitic shell covering its whole surface. Actually such a shell covers only one-third of the surface: what has become of the rest?

Now the idea is by no means new that the moon has

been formed by separation from the earth. This has been put forward by many mathematical cosmogonists, including Sir George Darwin. It has even been suggested that the vast oceanic Pacific basin represents the scar left by the departure of the moon. More recently a good deal of doubt has been cast on the possibility of such an origin for the moon; one of the latest writers on the subject, however, H. Jeffreys ("The Earth," 1924), says that the separation of the moon, *if it occurred at all*, must have taken place soon after the formation of the first solid crust of the earth. The possibility is therefore not totally excluded. It is suggested here that the facts of geology and the theories of physical chemistry afford a considerable measure of support to this speculation. To state the matter shortly, the suggestion here made is that the moon represents the missing two-thirds of the earth's earliest-formed granitic crust, stripped off by some form of tidal resonance, and rolled up into a ball while still more or less plastic. Whether such an event is possible is obviously a subject for mathematical investigation. A very similar idea has already been put forward by Prof. W. H. Pickering.

The purely arithmetical side of the question presents no difficulty. It is easy to calculate the thickness of crust required to be stripped off two-thirds of the earth's surface to form a globe of the size of the moon. When the calculation is made, it gives the surprisingly small result of only 41 miles or about 60 kilometres. This is less than the calculated depth of the isostatically floating continental blocks.

It is true that the present density of the moon, 3.46, is somewhat higher than that of the continental rocks, but it is probable that, at the time of the disruption, more or less of the underlying heavier material would be torn away along with the lighter portions, and there may of course have been also condensation by gravity-pressure in the moon, though this is unlikely to have been important.

Not only do the existing continents cover only one-third of the earth's surface, but their distribution is also very uneven. It is well known that by far the greater part of them are concentrated within the hemisphere having N.W. Europe at its centre. This concentration is so far favourable to the present theory. But it is necessary to take into account the significance of the ideas as to the wanderings of continental blocks as summarised by Wegener. If this theory, which is still very much *sub judice*, be accepted, it implies that, on the whole, most of the continents were once still more concentrated into one area than they are now. It is still too early to claim Wegener's theories as evidence in confirmation of the ideas here set forth, but at any rate there is nothing antagonistic in them. It is a somewhat natural inference that a large continental block, or group of blocks, left floating after the disruption in a viscous substratum, and obviously in a state of imperfect equilibrium, would tend to drift about. But the disruption must have happened at an early stage, while the movements postulated by Wegener belong to a comparatively late stage of geological history and are supposed to be even now in progress. Still, if we accept the doctrine of isostatic flotation at all, as most writers now appear to do, the continental blocks can obviously rise and sink, so they

may just as well be supposed capable of moving sideways also.

It may be noted that the formation of the moon by the segregation of a portion of the earth's crust bears a close analogy to the formation of planets from the sun by near approach of another star, as now held by many recent writers. If the aggregation to a spherical form is possible in the case just mentioned, it should be equally possible in the case of a crustal mass stripped off by tidal resonance; it is even conceivable that the disruption of the earth may have been caused by a similar cosmical disturbance due to the approach of some other body, but as to this there appears to be no evidence, and the tidal resonance theory offers the simplest explanation.

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## Obituary.

SIR RICKMAN JOHN GODLEE, BART.

BY the sudden death of Sir Rickman Godlee on April 20, science loses a singularly open-minded man of varied gifts and wide interests, who was intimately associated with the great revolution in surgery accomplished by his famous uncle, Lord Lister. In fact, Godlee is now most widely known as the author of Lister's biography, which is not only a worthy record of one of the greatest incidents in the history of science, but also a graphic picture of the simple, homely society in which the sterling characters of Lister and of Godlee himself were moulded. During his long career Sir Rickman played many parts, as senior demonstrator of anatomy and afterwards professor of clinical surgery at University College, London, and honorary surgeon at University College Hospital, as president of the Royal College of Surgeons, as surgeon to the household of Queen Victoria, and surgeon-in-ordinary to King Edward VII. and King George V.

As an anatomist Godlee displayed exceptional skill in dissection, and in addition he was a superb draughtsman. These gifts were displayed not only in his contributions to "Quain's Elements of Anatomy," but also in his own "Atlas of Human Anatomy" (1880). But perhaps his chief contribution to anatomy was his investigation of cranio-cerebral topography, which his pioneer work in cerebral surgery impelled him to undertake.

At the Hospital for Epilepsy and Paralysis (then in Portland Terrace, overlooking Regent's Park) Godlee performed the hitherto unprecedented operation (in England) of removing a tumour from the brain, after its position had been determined on the evidence provided by Sir David Ferrier's experiments on animals. This milestone in the history of surgery was made more conspicuous still when particular attention was directed to it in the *Times* of December 16, 1884, for the purpose of rebutting Ruskin's attack on vivisection.

Godlee's interest in University College and its anatomy department was maintained with unabated vigour until the end. His loss will be particularly felt this year, not merely for personal reasons, but also because his intimate knowledge of the College

and of University College Hospital and his rare literary gifts were being devoted to the preparation of the history to celebrate the centenary next year.

In spite of his seventy-six years, Sir Rickman had retained his mental and physical vigour unimpaired. After his retirement from surgical practice in 1920 he was free (at his beautiful home at Whitchurch, near Pangbourne) to devote himself with new zeal to those interests in Nature—geological, botanical, and zoological—concerning which his knowledge was amazingly wide and exact. Nor did he allow these interests to affect his devotion to art. An exceptionally gifted draughtsman himself, he was keenly interested in etchings and engravings, of which he had a characteristically critical but appreciative knowledge.

Frankly outspoken and always open-minded, Sir Rickman Godlee's opinions and advice were much valued by his friends.

## SIR D. GOLDSMID-STERN-SALOMONS.

SIR D. GOLDSMID-STERN-SALOMONS, better known perhaps by his earlier name of Sir David Salomons, died at his residence at Broomhill, Tunbridge Wells, on April 19, at the age of seventy-three. He was educated at University College, London, and Gonville and Caius College, Cambridge, where he graduated in the Natural Science Tripos of 1873. His uncle was Sir David Salomons, who made a long fight for admission to the House of Commons and was the first of the Jewish faith to sit there. His uncle warmly encouraged Sir David's interest in physics and engineering. He equipped a physical laboratory for him, and a few years later a workshop and a small electric generating station were added to it. Sir David was undoubtedly one of the earliest pioneers of electric lighting for use indoors. He claimed that so far back as 1874 he used incandescent lamps for house lighting. He was a most enthusiastic inventor, making for himself all the electric switches and other devices which he required. He was one of the first to realise the difficulties in the way of heating and sparking that had to be overcome. No one outside the electrical profession realises the immense amount of research and ingenuity that has been

expended in developing the ordinary domestic electric switch.

Sir David took a great interest in the development of engineering in France. He was one of the eight founders of the Aero Club de France, and was a founder and an honorary member of the Automobile Club de France. In the early days, long before there seemed to be any commercial possibilities in automobiles, he had a motor car, and later on he helped the industry by assisting in the formation of the Royal Automobile Club, of which he was a vice-president. He was the author of several books, of which the best known is "Electric Light Installations and the Management of Accumulators," which is now in its eleventh edition. For many years this was practically the only book on the subject, and was in the library of almost every electrical engineer. He also carried out important researches, and made inventions in connexion with electric signalling apparatus, speed indicators and fire-proofing material.

As a member of council Salomons took a great interest in the management of the Institution of Electrical Engineers, with which he was closely connected almost from its inception. He was honorary treasurer for many years, and a vice-president for five years. In 1895 he would, in the ordinary course of affairs, have become president had not several members of council objected. They said that the president of a professional institution should only be a member who was in actual practice. He was president of the Electrical Trades Benevolent Institution, and took a great interest in its prosperity. He was also very interested in the training of young engineers, and founded several valuable scholarships. In his later years he devoted much time to photographic developments. His only

son lost his life by drowning in 1915 when on active service.

Sir David was a good citizen and took a leading part in municipal, political and social affairs. He will be sadly missed by the older generation of electrical engineers, who will always remember his useful pioneering work.

A. R.

WE regret to announce the following deaths:

Dr V Ebner, Ritter v. Rofenstein, professor (1888-1913), and emeritus professor of histology in the University of Vienna, and a member of the Vienna Academy of Sciences, distinguished for his contributions to embryology and histology, on March 21, aged eighty-three.

Dr. G. S. Fullerton, formerly professor of philosophy in the University of Pennsylvania and in Columbia University, and president in 1895 of the American Psychological Society, on March 23, aged sixty-five.

Dr. W. H. Julius, professor of experimental physics since 1896 in the University of Utrecht, and known for his work in astrophysics on anomalous dispersion, on April 15, aged sixty-four.

Dr. Frédéric Morin, president of the Station Climatérique de Leysin, Switzerland, and one of the founders and later a president of the International Union against Tuberculosis, aged seventy-two.

Mr. J. A. Parkhurst, for twenty-five years on the staff of the Yerkes Observatory, and associate professor of astronomy in the University of Chicago, who made contributions to our knowledge of photographic and visual stellar magnitudes, on March 1, aged sixty-three.

Prof. Eduard F. L. Mazelle, formerly Director of the Observatory, Trieste, a corresponding member of the Vienna Academy of Sciences, distinguished for his work on meteorology and seismology, on January 26, aged sixty-two.

### Current Topics and Events.

MONDAY next, May 4, will be the centenary of the birth of Thomas Henry Huxley, and the event is one to be held in grateful recollection by all who esteem the pursuit of scientific truth or see the light to which it leads. As a tribute to the memory of this great naturalist and teacher, we are issuing with next week's NATURE a special Supplement containing a remarkable collection of articles surveying his scientific work from various aspects and relating the personal reminiscences of the few remaining people who were in close contact with him during his life. It is very rarely that a great man of science is also a great leader in social and intellectual development, but in Huxley these two qualities were brilliantly combined. The four volumes of his scientific memoirs establish his place in scientific history, and the papers in them display deep insight as well as extraordinary powers of generalisation. As examples of his scientific genius mention may be made of his recognition of the fundamental character of the endoderm and ectoderm, his demonstration of the close affinities between reptiles and birds, and of the ancestry of the horse, and his work "On Man's Place in Nature," in which he showed that the anatomical differences between man and the higher apes were no greater than those between the higher

and lower apes, and thus provided substantial evidence of the extension of the evolutionary principle to man. The full significance of this work can be understood only in scientific circles, in which it has taken a permanent place. To the public he was a fearless champion of scientific thought and intellectual freedom, possessing exceptional gifts of lucid exposition in his literary style and lectures, and using them continuously in social service. The symposium which we shall publish in our next issue will, we hope, induce workers and thinkers of the present time to turn to Huxley's life and writings for the stimulus and guidance which are as much needed now as they were in his own days if science is to come into its kingdom.

THE Governors of the Imperial College of Science and Technology, South Kensington, have made special arrangements for the celebration of the centenary of Huxley's birth. During the afternoon of Monday next, May 4, there will be an exhibition in the Zoological Department of the College, followed after tea by an address to be given by Prof. E. B. Poulton on Huxley's zoological work, and in the evening at 8.30 a reception will be held by Lord Buckmaster (chairman of the Governing Body) in the

Royal School of Mines, Prince Consort Road. Huxley was professor of biology at South Kensington from 1854, and was Dean of the Royal College (then Normal School) of Science and the Royal School of Mines from 1881 until his death in 1895. He was also actively interested in the formation of the Central Technical College, which is now, under the name of City and Guilds (Engineering) College, one of the three institutions federated to form the Imperial College. It is thus appropriate that the chief memorial of Huxley's great work should be in some form at South Kensington, and the Governors of the Imperial College hope to raise sufficient funds for a suitable purpose. In moving to this end, the Governors are following the advice given them in 1923 by a meeting of the representatives of the principal institutions with which Huxley was actively connected, including the Royal, Linnean, Geological, and Zoological Societies, the British Association, the Board of Education, as the official successors of the old Science and Art Department, the Education Committee of the London County Council, as the successors of the London School Board, the Hydrographic Department of the Admiralty, the Royal College of Surgeons, the University of London, and the Natural History branch of the British Museum. For the future May 4 is to be recognised at the College as an annual holiday.

In our issue of April 25, p. 613, reference was made to the fact that the American Museum of Natural History depends largely for financial support on a large body of regular subscribers, and it was suggested that it would be well if the British Museum (Natural History) could obtain similar assistance. That additional funds are needed for work of the first scientific importance is obvious from the letter appearing elsewhere in this issue (p. 638) from Sir Sidney Harmer, Director of the Museum. A modest expedition has been sent out to Tanganyika Territory by the Trustees of the British Museum to a locality which is known to be rich in dinosaur remains, and the funds in hand will allow of work during the present season on a limited scale. It would appear that the remains, including some of gigantic animals, are lying on the surface or close beneath it, and that a well-fitted expedition could obtain specimens which would be of inestimable value to science. However, as Mr. C. W. Hobley pointed out in *NATURE* of April 18, p. 573, in an article describing the region and its inhabitants, the conditions are such that the best results can only be obtained by a carefully organised expedition with full technical and transport staffs. Sir Sidney Harmer's letter should drive home the urgent needs of the expedition and will, we hope, produce the necessary and practical assistance which he asks. The American Museum of Natural History has been able to fit out an expedition to Central Asia which has been in the field for several years in succession, exploring and digging with striking results. It is surely not too much to expect that the appeal for the comparatively small fund necessary to work an area already known to be strewn with interesting animal remains will meet with ready response.

THE name of Prof. Bohuslav Brauner, Director of the Chemical Institute of the Charles University of Prague, is familiar to many men of science in Great Britain and elsewhere. It is therefore a pleasure to congratulate him on attaining his seventieth birthday on May 8. Prof. Brauner is a grandson of K. A. Neumann, the first professor of chemistry at the Polytechnic High School in Prague. He speaks and writes fluently in no less than six languages, namely, Czech, English, German, French, Russian, and Italian, in addition to a perfect knowledge of Latin and Greek. In chemical science he has acquired an international reputation. He was the first to liberate (in small amounts) the element fluorine from fluoplumbates, and established the complex nature of didymium, separating out the praseodymium. The well-known "critical discussions" of the atomic weight determinations which preface the accounts of each element in Abegg's "Handbuch" are his work. He was an early and vigorous supporter of Mendeléeff's periodic classification of the elements. Prof. Brauner established, but not without opposition, that beryllium is a divalent metal and has an atomic weight 9, thus heading the group of alkaline earth metals in Mendeléeff's system. He was also instrumental in securing the adoption of oxygen (16) as the basis of atomic weight determinations, a large number of which he carefully re-determined himself, devoting much effort to a valuable study of the rare-earth metals. In Bohemia he has done much to foster an interest in science, and through his efforts in 1903-4 the Chemical Institute was erected. In commemoration of his seventieth anniversary a "Jubilee volume" (mainly in English) is being published as a special number of the *Recueil des Travaux Chimiques des Pays-Bas* (price 12s. 6d. from Dr. W. P. Jorissen, 11 Hooze Rijndijk, Leiden, Holland). This volume will contain thirty-four communications from Prof. Brauner's friends in England and abroad, including prominent chemists, and describing original and recent researches, hitherto unpublished, in general, inorganic, analytical, organic, physical and electro-chemistry. It will certainly be of interest to many chemists and physicists.

REFERRING to a point in our leading article on February 21, Mr. A. E. Bostwick, librarian of the St. Louis Public Library, Olive, 13th and 14th Streets, St. Louis, Missouri, writes stating that *aeroplane* is derived from *aero-* + *planet*, as is given by the American New Standard Dictionary (1914), of which Mr. Bostwick was an associate editor, and as is correctly illustrated in the title of the Norwegian publication the "Aeroplanet"—the air wanderer—(1918). It is difficult, however, to see how the final *t* of the Greek root can be dropped to form *aeroplane*. The New Dictionary of the English Language, Oxford, gives the usual derivation from *aero-* + *plane*, which is unassailable so far as Great Britain is concerned. The word *plane*, as denoting surfaces which are "substantially" flat, in patent law jargon, has been established by the custom of more than a century, while the evolution of *aeroplane* to denote first a lifting surface and afterwards a flying machine is

more than half a century old. Sir George Cayley introduced *plane* in this sense in his remarkable articles on "Aerial Navigation," in *Nicolson's Journal of Philosophy* (1809), and Thomas Walker uses *plane* for wings, shown as curved in sketches, in his "Treatise on Aerostation," 1831. F. H. Wenham introduced *aeroplane* to denote a lifting surface in the first report of the Aeronautical Society (1866), and D. S. Brown used *aeroplane* to denote a complete flying machine in the Society's eighth report (1873). Our correspondent further suggests, out of wide experience of American libraries, and of editorial work on encyclopedias and dictionaries, that in the United States *aeroplane* holds its own in technical discussions, and is used as frequently as *airplane*. The point made in our leading article was that the National Advisory Committee for Aeronautics had adopted *airplane* officially. It also appears in numerous aeronautical and engineering journals of standing, but this need not controvert Mr. Bostwick's estimate for the whole range of American publications.

WE have received from the Science Society of China a pamphlet setting out, from a Chinese point of view, how best the Boxer Indemnity could be used. The Society is of opinion that a golden opportunity which occurs once in a thousand years would be lost, or indefinitely postponed, if the funds available either were divided among the Provinces or were devoted to river conservancy or railway construction, but that a maximum of usefulness might be attained if they were expended on pure research work. This is interpreted to mean the establishing of a model national research laboratory for physical, chemical, biological, and industrial work, the subsidising of laboratories of good repute, whether existing as independent institutions or as forming part of universities, and the founding of scholarships for research students. Besides this, the Society favours the establishing of libraries and museums and the endowing of Chinese chairs of literature and philosophy in foreign universities, but fears that the sums available—strangely understated, dollars being confused with pounds—will not cover so large a programme. The Society is strongly of opinion that general principles should be settled before individuals are appointed to allocate the funds. These should be, it is suggested, entrusted to a Board of Trustees under exact terms of reference, and the members, who should be scholars of repute and men of sterling character, should be appointed equally by both countries.

THIS scheme of the Science Society of China, which was published last August, was in September followed as to its general outlines in the scheme adopted by the United States. It doubtless sets out the results of the negotiations which actually took place between Peking and Washington. We note that the Society restricts its suggestions to the advancement of science, concerning itself with instruction rather than education, and limits co-operation between Chinese and foreigners to partnership on a Board concerned solely with the allocation of funds. To us this seems a somewhat barren use of the golden opportunity depicted. What China needs in its

education, besides the addition of science to letters, is a system which aims at producing leaders and not merely students; and to promote this she needs in the educational field that kind of help from foreigners, which has brought stability and efficiency into the customs and the postal services by firmness of administration.

EVERY student of the natural sciences must be familiar with the name of Joseph Leidy, and yet each one may wonder at his fellow's familiarity. Few to-day can approach Nature from so many sides and to such good effect. Leidy was for thirty-eight years professor of human anatomy in the University of Pennsylvania; he was for forty-six years an officer of the Philadelphia Academy of Natural Sciences. As author of "A Flora and Fauna within Living Animals" (1851) and of sixty papers on the subject, he is rightly claimed as the father of American parasitology; and yet he has equal right to be styled father of American palæontology; his most perdurable, and probably his best-known, work is the beautiful monograph on "Fresh-water Rhizopods of North America." He was a mineralogist, well versed in gem-stones; his first collection was of flowers, and he was a competent botanist. His skill as a draughtsman and his love of natural objects made him primarily a descriptive naturalist, and as such pre-eminent. "he never," says Dr. H. F. Osborn, "made an incorrect observation or published an incorrect figure." But he was no mere accumulator of facts, for he was an evolutionist before Darwin, an experimental critic of spontaneous generation before Pasteur. It was, indeed, fitting that the centenary of his birth should have been commemorated on December 6, 1923, at Philadelphia, and that there should now have been issued a verbatim report of the many admirable addresses delivered on that occasion; but we regret that no indication is given of where or how the report can be obtained.

THE opening of the Lewis Evans' collection of historic scientific instruments in the Old Ashmolean Building at Oxford has been arranged for May 5. The ceremony will be preceded by the conferment of the degree of D Sc. *Honoris causa* on Mr. Lewis Evans in the Convocation house. At 2.30 P.M. the Earl of Crawford and Balcarres will deliver an address in the Divinity School and will then pay a formal visit to the collection in the Old Ashmolean Building. The collection will be open to the general public on weekdays between the hours of 11 and 4. An illustration of the building appeared in NATURE for March 3, 1923, on the occasion of the Wren bicentenary celebrations, and Mr. R. Gunther informs us that he has since found additional evidence in support of his view that this building, with but small alterations, is the "College of Science" that was designed by Wren to be erected on the site in Arundel Gardens presented to the Royal Society by Henry Howard. Proving too costly, the building was not erected in London, but when a scientific institution was needed for the Oxford Philosophical Society and for Ashmole's "rarities," Wren's old plan was adapted and adopted.

THE annual congress of the South-Eastern Union of Scientific Societies to be held at Folkestone on June 3-6 should attract a large number of delegates and friends. The officers of the Union for the coming year are as follows: *President-elect*, Sir John Russell, Director of the Rothamsted Experimental Station; *Presidents of Sections*, Botanical, Mr. A. G. Tansley; Geological, Mr. A. L. Leach; Zoological, Mr. E. C. Stuart Baker; Regional Survey, Mr. Geo. L. Pepler. The presidential address to the congress will deal with the place of science in rural life, and is certain to be of much interest. Mr. Tansley, in his address to the section over which he presides, will deal with the vegetation of the English chalk, Mr. Leach with new road sections in north Kent, Mr. Baker with field naturalists and evolution, and Mr. Pepler with regional survey in east Kent. The evening lectures will be by Mr. D. Ward Cutler on "Life in a Garden Soil," Sir Arthur Smith Woodward on "The Evolution of Fishes," and Capt. J. J. Eckersley on "Broadcasting." The afternoon excursions include a novelty in the shape of a trip to Dungeness, that wild and remote shingle-tract which forms the seaward extension of Romney Marsh. Here both plant and animal life are unique and fascinating. Dover Castle, and the country behind Dover, will be visited, as also the recently excavated Roman remains at Folkestone, and several other places of interest. A Congress Museum, exhibiting current work by members of the Union, is in course of preparation, and should prove a most attractive adjunct to the gathering. A Handbook of Local Surveys is being prepared and will be published before the congress. The chapters—about twenty in number—will deal with local flora and fauna, geology, ecclesiastical architecture, Romano-British remains, and other subjects of interest. Copies of the book (price 2s.) may be ordered from the Secretary of the Folkestone Natural History Society, 16 Manor Road, Folkestone, who is also one of the local secretaries of the Congress.

THE first of the two annual conversaciones of the Royal Society is to be held on Wednesday, May 13, at 8.30.

SIR THOMAS H. HOLLAND, Rector of the Imperial College of Science and Technology, South Kensington, and formerly Director of the Geological Survey of India, has been elected president of the Institution of Mining and Metallurgy.

WE learn that it is intended to undertake the preparation of a biography of the late Dr. W. H. Maw, editor for many years of our esteemed contemporary, *Engineering*. Those of his personal friends, colleagues or correspondents who may have interesting material, especially in the shape of personal reminiscences or letters, to contribute, are requested to communicate with Mr. W. E. Simnett, c/o The Institution of Civil Engineers, Great George Street, London, S.W.1.

THE World List of Scientific Periodicals has now grown considerably beyond its original size, with the result that the next issue will be in two volumes, one to be issued this month, and the other by the end of the year. The List will be published by Mr. Humphrey Milford of the Oxford University Press.

Subscriptions from Great Britain and Ireland will become due on May 15 and from other parts of the world at later dates: they should be addressed c/o Zoological Society, Regent's Park, London, N.W.8.

DURING the course of a recent lecture to the Society of Glass Technologists on "Glass as an Instrument of Human Progress," Prof. W. E. S. Turner stated that he has had discussions very recently with manufacturers of optical instruments as to the best source of optical glass at the present time. It is very gratifying to learn that in the view of manufacturers whose reputation depends on their obtaining optical glass of the finest qualities, British optical glass is regarded as entirely superior to that of Continental or other makes. Two well-known instrument makers expressed the opinion that in view of the prejudices, both of the general public, and frequently, also, of scientific workers, in favour of instruments made from Jena optical glass, the present state of affairs ought to be widely advertised.

THE value of the intensive study of a small region as an introduction to wider geographical work is now recognised in most schools of geography and also in some secondary schools. A useful pamphlet, which claims to be no more than a guide to methods and sources of information, has been written by Mr. C. G. Beasley ("Local Geography." London: T. Murby and Co. Price, 1s. 6d.). The pamphlet begins with a scheme of regional survey in which Mr. Beasley shows how to link the human with the physical geography of a district, and discusses the preparation of a map or diagram to show types of land utilisation. The last section of the book is a useful but not exhaustive account of the sources of information. The pamphlet merits the attention of teachers who aspire to give a sound basis to their geographical work.

WE have received Heft 1 (for January) of a new German monthly periodical—the *Anzeiger für Schädlingkunde*. It is intended for the publication of short original articles and also as a medium for issuing notes and other announcements relating to the German Society of Applied Entomology, to the members of which it is supplied gratuitously. The editors are Dr. K. Escherich of Munich and Dr. F. Stellwaag of Neustadt a. H. The journal is published by the firm of Paul Parey of Berlin, and the present issue consists of twelve pages, but its size (28 cm. × 20.5 cm.), double columns and small type, allow of a larger amount of letterpress than might appear at first sight. It contains four short contributed articles and certain news items. The articles include one by Dr. Escherich, on the transference of wireworms through forest-litter (Waldstreu), and a longer contribution by Dr. H. Eidmann on the pyralid moth *Dioryctria splendella* H.S. and its importance to forestry, both articles being illustrated by text-figures. The other contributors are Dr. A. Frhr. von Vietinghoff-Riesch, who writes on the pine moth and the bird world, and Herr Jac. Schlösser, who describes his experiences with arsenic "burning" in the control of fruit-tree pests.

SOME indication of the valuable work which is being done by the Canadian Government in investigating

the customs and beliefs of its Indian population, as well as in preserving a record of such of their traditional songs, legends, and ceremonies as have not already passed beyond recovery, is furnished by the Report of the Department of Mines for the period ending March 31, 1924, which has just been issued. The section dealing with the work of the Anthropological Section of the Victoria Memorial Museum shows that, in the course of the year, six scientific trips were undertaken which covered investigation among the Bella Coola, the Gitksan of Skeena River, British Columbia, the Carrier Indians of Bulkley River, B.C., and archæological excavations in Ontario. Some of the results of these expeditions were submitted to the British Association at the Toronto meeting last year. Perhaps the most noteworthy material obtained was that bearing upon the ceremonial dances of the Bella Coola by Mr. McIlwraith, which have thrown much light upon Indian psychology and afforded an opportunity for collecting valuable information on the chieftainship, government, magic, mythology, etc. More than one hundred songs were recorded by phonograph.

In September of last year the Fuel Research Board of the Department of Scientific and Industrial Research issued a pamphlet which described the Arley Seam of the Lancashire Coalfield, and pointed out that this was to be the first of a series of similar pamphlets dealing in detail with the physical, chemical, and other characteristics of the individual coal seams of Great Britain. In pursuance of this scheme the

Board has recently issued Part 1 of a report on the Ravine Seam of the same coalfield. (London: H.M. Stationery Office, 1925. 1s. 6d. net.) The seam is fully described in all its details, as it appears in different parts of the field, the variations which it undergoes being clearly indicated. There are numerous analyses, proximate and ultimate, together with a good study of the composition of the inorganic matter present. Washery tests and microscopical examination of the coal are also included. It is to be regretted that the more modern method of X-ray examination of the coal in order to determine the distribution of its inorganic contents has not been made use of. It is stated in the preface that "large scale experiments, including steam raising tests, the carbonisation of the coal at low and high temperatures, and the utilisation of the coke in a water gas plant, are in progress at H.M. Fuel Research Station, and the results will be published as Part 2 of this report."

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: an assistant lecturer in geography in the University of Manchester—The Internal Registrar (June 8); a probationer for the Indian Forest Service—The Secretary, Services and General Department, India Office, S.W.1 (July 1); principal of Agra College—The Commissioner of Agra, India (July 10); a reader in organic chemistry in the University of the Punjab, Lahore—The Joint Registrar (July 31); a physics laboratory attendant in the Science Department, University of Durham—Head of the Department, South Road, Durham.

### Our Astronomical Column.

COMETS.—Mr. B. M. Peek of Boscombe and Mr. G. P. B. Hallows of Wimborne have succeeded in obtaining a considerable number of observations of Reid's Comet though its meridian altitude was only  $11^\circ$ . Two of Mr. Peek's observations are given (referred to the equinox of 1925.0).

GMT.	RA.	S. Decl.
Apr 15 <sup>d</sup> 22 <sup>h</sup> 54.5 <sup>m</sup>	13 <sup>h</sup> 3 <sup>m</sup> 39.68 <sup>s</sup>	25° 59' 37.3"
24 22 13.4	12 50 1.36	28 12 48.0

They are corrected for differential refraction, but not for aberration or parallax. Taken in conjunction with the early observations given a few weeks ago, they will permit the deduction of improved elements.

A new orbit of Orkisz's comet has been computed at Copenhagen; but it differs so slightly from Mr. Merton's orbit (NATURE, April 25, p. 616) that it is unnecessary to give it. Prof. Banachiewicz of Cracow has directed attention to the resemblance of the orbit of the comet of 1500, for which Dr. Hind found the following elements from Chinese observations:  $T$  1500 May 17,  $\omega$   $20^\circ$ ,  $\Omega$   $310^\circ$ ,  $i$   $105^\circ$ ,  $\log q$  0.146. It is desirable to observe the comet as long as possible in order to decide the question of identity. Since it is travelling into high north declination, it is well placed for this purpose.

The following orbit of Schain's Comet has been deduced by Dr. A. C. D. Crommelin from observations on March 23 at Bergedorf, April 2 and 14, by Dr. W. H. Steavenson at Norwood.

$T$ = 1925 Aug 6.918 G M T (new)
$\omega$ $200^\circ 31' 10''$
$\Omega$ $357^\circ 29' 12''$
$i$ $146^\circ 55' 47''$
$\log q$ 0.629662

$T$  is not likely to be more than a few days in error. Unfortunately, the comet will be hidden in

the sun's rays at the time of perihelion, but it will be observable again from November onwards.

It should be noted that this comet was independently discovered by Señor Comas Solà at Barcelona a day after Mr. Schain detected it: custom therefore allows the coupling of the two names as joint discoverers, as the second detection took place before the news of the discovery had been distributed. Both discoverers found the comet in the course of their regular photographic search for new minor planets.

PROPOSED NEW ASTRONOMICAL CO-ORDINATES.—In the *C.R. Acad. Sci.*, Paris, March 2, M. C. Solà points out that, in order to study the sun's motion, a system of co-ordinates is required which does not rotate. A uniform rectilinear motion of translation of the origin need not be considered, since in infinite space such a motion has no real meaning. Since the position of the centre of gravity of the Milky Way is not known, it cannot be employed as the origin, and a system of axes based on the stars, particularly the brighter ones, most of which have definite proper motions, cannot be regarded as necessarily free from rotation. Under these conditions, it is better to take the centre of the sun as origin, and to measure the position of the stars in the different streams which form the Milky Way with respect to axes passing through it, and fixed with respect to the most distant objects visible, such as the globular star clusters, or, possibly better still, the spiral nebulae. As these can be regarded as being practically at an infinite distance with respect to the bright stars, the axes so defined could be regarded as practically free from rotation. It is pointed out that modern astronomical knowledge demands the degree of exactitude which could be obtained in this way.

## Research Items.

**THE GOD SETEKH.**—Some interesting deductions bearing upon the development of religious beliefs in ancient Egypt are made by Mr. R. O. Faulkner in the March number of *Ancient Egypt* from references to the god Setekh in the Pyramid Texts. The centre of the worship of this little-known deity appears to have been Ombos in Upper Egypt, and he appears to have been to some extent the embodiment of the destructive powers of Nature. In the Osiris and Horus myths of the later texts stress is laid upon his malevolent activities; but the Pyramid Texts, the oldest beliefs concerning him which have come down to us, present contradictory ideas which probably represent different stages in his history. Originally he ranked as equal with the other gods. Thus his relations with Horus and Osiris vary in three ways: (1) Setekh is without either friendliness or hostility, but stands over against them as representing a different tract of the country; (2) Horus and Setekh co-operate for the benefit of the deceased; (3) Setekh is the mortal foe of Horus. As the Osiris cult gained ground Setekh became hostile to him also. It is not always clear whether Horus is the old tribal Horus or the son of Isis. Probably the tribal myth was transferred bodily into the Osirian legend, the original cause of hostility being the feud for the supremacy of Egypt settled in the lawsuit which was brought before the court of the gods at Heliopolis. The reversal which converted Setekh from one of the principal gods of the Egyptian pantheon to an outcast was no doubt due to political causes, and the frequency with which he appears as the enemy of Osiris is to be attributed to the comparatively late rise of the cult of that deity when the evil character of Setekh had been fully established.

**IRISH SEA HERRING.**—The report for 1923 on the Lancashire Sea-Fisheries Laboratory contains three papers dealing with investigations into the life-history and fishery of the herring in the Irish Sea. Mr. A. Scott, from the results of his examination of stomach contents, concludes that the movements of both herring and mackerel are influenced to a very considerable extent by the presence or absence of plankton organisms, and believes that it should be possible to predict with a fair amount of accuracy whether these fishes will arrive earlier or later than usual, by making adequate observations on the plankton. The food of the herring during the fishery in June, July and August 1923 consisted of the few months' old stages of fishes such as rockling, sand-eels, clupeoids, gurnard and long rough dab, along with the crustaceans *Meganocyprhanes*, zoea and megalopa stages of crabs, larval pagurids, *Pandalus*, and various Copepoda. Mr. W. C. Smith, in a study of the composition of the Manx herring shoals, states that young fish approach the coast in May and remain close to the land for about three months, increasing in abundance during June and July, and moving to the deeper water off the Calf of Man in August. Older fish come in later, appearing on the Irish side of the Channel in July, and gradually working across to the "Calf" waters to meet the other shoals in August. Mr. W. Birtwistle and Miss H. M. Lewis made an extensive examination of Irish Sea herrings in 1923 with regard to age, growth, and maturity, and now put forward two interesting hypotheses: (1) Irish Sea herrings are all autumn spawned, (2) herrings spawned in the very early autumn will show a greater mean length and a more advanced mean stage of maturity than herrings spawned in the late autumn.

**SEX DIFFERENTIATION IN THE CHICK.**—In a paper published in 1921 (*Jour. Exp. Zool.*, v. 33), Minoura

put forward the claim that he was able to produce in the developing chick embryo intersexual forms due to the action of the sex-hormones secreted by a gonad of the opposite sex grafted on to the chorio-allantoic membrane. His work was of fundamental importance, since it provided the only experimental support of Lillie's theory of the causation of free-martin in cattle. Minoura's experiments were recently repeated by A. W. Greenwood (*Brit. Jour. Exp. Biol.*, 2, No. 2, 1925). The technique has been greatly improved and a sex-linked cross was used, making it possible to identify the sex of the chicks at an early stage in development. Although the author obtained many successful grafts, he has entirely failed to confirm Minoura's results. He shows that Minoura cannot be said to have demonstrated conclusively that the differentiation of the sexual apparatus of the host embryo can be modified towards an intersexual condition through the action of a gonad graft of the opposite sex. Further, he shows that the conditions obtaining in the bovine free-martin are not reproduced in these experiments, in that in the latter the embryo is exposed to the specific action of the grafted gonad alone, whereas in the former the female co-twin is exposed to the action of all the internal secretions from the male.

**A MULTIPLE TEMPERATURE INCUBATOR.**—C. B. Williams and T. W. Kirkpatrick describe (Ministry of Agric., Egypt, Technical and Sci. Service, Bull. No. 38, 1924) useful forms of this apparatus designed to enable them to study the behaviour of cotton pests at a number of different temperatures in order to find their death-point, the points of greatest and least activity, and their rates of development at temperatures close together and approximately constant. A copper or aluminium bar, tube, or trough is inserted at one end into a hot tank and at the other end into an ice-box—all suitably insulated so as to minimise changes of temperature. In the first apparatus a copper bar was employed, and in this 71 holes were bored at intervals; each provided a place where a tube could be maintained at a different temperature the daily variation of which was found in any one case to be less than half a degree. The authors suggest that bacteriologists and mycologists may find the apparatus useful.

**A NEOTENOUS SALAMANDER FROM JAPAN.**—M. Sasaki (*Jour. Coll. Agric. Hokkaido Imp. Univ. Japan*, vol. 15, pt. 1, 1924) gives an account of the bionomics of a salamander, *Hynobius lichenatus*, which, in Lake Kuttarush, occurs as a typical neotenus form, regularly breeding in that phase. While the phenomenon of neoteny is not rare, particularly among the Urodela, reproduction in the neotenus condition has hitherto only been known in the Axolotl. The larvae of neotenus parents underwent normal metamorphosis under laboratory conditions. From experiments the author concludes that the main factor which brings about neoteny is low temperature, to which, however, must be coupled a rich food supply. The temperature must not be so low as to impair the vitality of the animals and inhibit feeding, since starvation, even under otherwise good conditions, stops both growth and metamorphosis. Conditions suitable to neoteny, a permanent temperature of from 4°-10° C. and a rich food supply, were found to exist in the Nitella zone of Lake Kuttarush, where neotenus forms of *Hynobius lichenatus* were found by the author in abundance and regularly reproducing.

**EMULSIFIED OIL-SPRAYS FOR LEMON CULTURE.**—A large number of the lemon groves of Florida are

located in artesian well districts, and the water from these wells is utilised in spraying the trees for white flies and scale insects. Unfortunately this water is particularly hard, and great difficulty is met with in mixing unstabilised oil-emulsions with it. Accordingly the water was treated with caustic potash fish-oil soap prior to adding the emulsion, but the method involved trial and error; caustic soda and fish-oil soap, used separately, were found more economical. Where the rust mite prevails, as in the United States and the West Indies, other measures have to be taken. Messrs. W. W. Yothers and J. R. Winston give details of the use of combination sprays both for rust mite and for other insects, in Bulletin 1217 of the United States Department of Agriculture (1924). These sprays concern the use of soda-sulphur or potash-sulphur solutions mixed with unstabilised oil-emulsions, but they are not always so effective as they might be, and a lime-sulphur solution has been employed to greater advantage as an insecticide. Unfortunately there is again a difficulty in getting the lime-sulphur solution to mix with unstabilised oil-emulsion. Experiments in the direction of stabilising oil-emulsions have shown that the use of colloidal substances such as glue, skimmed-milk powder, casein, wheat flour, corn-starch and laundry starch produces the desired effect. The combination spray is made by filling a spray tank full of water, to which is added the requisite amount of lime-sulphur solution; then the stabilised oil-emulsion is added, consisting, for example, of paraffin or lubricating oil, water, caustic soda, fish-oil soap, and glue. After agitation the spray is ready for use, and it can be applied to foliage, branches, or fruit without injury, providing that the whole process of mixing has been carefully carried out and the correct proportions of each ingredient employed.

UPPER AIR CIRCULATION OF THE ATLANTIC.—The upper air circulation of the Atlantic Ocean is dealt with by Mr. E. W. Barlow of the Meteorological Office, Air Ministry, in Professional Notes, vol. 3, No. 39. An historical account is given of upper wind currents and temperatures over the Atlantic obtained chiefly from kites and pilot balloons, and our present knowledge of air circulation in relation to trades and counter trades is indicated. The meteorological aspects of Atlantic flying are dealt with; these include sea-fog and conditions which create "bumpiness," and advice is given as to the most favourable heights for flights to North and South America. The work is of considerable interest, and the author has brought together a good deal of useful information. Some early discussions by the Meteorological Office, and especially those carried out under the supervision of Capt. Toynbee on the Atlantic equatorial regions, scarcely receive the attention they deserve. These earlier discussions show that in the region of the Doldrums, with north-east winds at the surface, the direction of upper clouds is generally from south-east, and with surface winds from south-east the upper clouds are about equally from south-east and north-east. To the north of the Doldrums and to 20° N., with wind north-east there is a high percentage of the upper clouds from south-west. To the south of the Doldrums and to 10° S., with wind south-east, there is a high percentage of upper clouds from south-west and a fairly high percentage from north-east. These results are obtainable for each month. Table IV., by the author, gives the times in hours required for flight between Newfoundland and Ireland under best, ordinary, and worst conditions. The Meteorological Office "Synchronous Weather Charts of the North Atlantic Ocean, 1882-3," have been used for these calculations. These charts represent the

weather conditions for a single year, and the weather in any other year would in all probability be very different, a fact which should be emphasised.

CLIMATE OF THE NETHERLAND INDIES.—The Royal Magnetic and Meteorological Observatory of Batavia, in Verh. No. 8, vol. 1, part 7, gives a discussion of the weather by Dr. C. Braak. In addition to the Dutch text English summaries are given. Favourable conditions for lightning and thunder appear to be calm air and an unstable vertical temperature distribution, extending to a great height. The bulk of tropical thunderstorms are heat thunderstorms, short-lived, and of relatively small extension. Fewer persons seem to be struck by lightning in the East Indies than in Europe, and fires caused by lightning are very rare. Special kinds of trees are struck fairly frequently, in particular the coco-nut palms. Hail is said to be a rare phenomenon in the tropics, but instances are given of the occurrence of hailstorms; they are most frequent in the monsoon changes, as is the case with thunderstorms. No marked connexion is shown between pressure and sunshine or pressure and temperature, but there appears to be a pronounced relationship between sunshine and temperature. A comparison is made between the climate of the Netherland Indies and that of other regions. With regard to temperatures of the wet bulb thermometer, it is noted that whilst at Batavia the maximum heat, although disagreeable, can be endured without too much discomfort, the same cannot be said of many other places in neighbouring countries. Destructive cyclones are rare. A comparison is made of the climates of those regions in the Archipelago and outside of it where the best results are obtained with different crops.

THE JAPANESE EARTHQUAKE OF SEPTEMBER 1, 1923.—Several papers have recently been published on the great Japanese earthquake of 1923, one of unusual interest being that by Mr. K. Shiratori (*Japanese Journ. of Astr. and Geoph.*, vol. 2, 1925, pp. 173-192). From the seismographic records at Sendai, he locates the epicentre in Sagami Bay off the southern end of the Miura peninsula, and the focus at a depth of 44 km. From September 1 until the end of the year, 652 after-shocks were recorded at Sendai, of which 80 were comparatively strong. The epicentres of the latter are distributed in three zones, together in the form of the letter N. The first zone is parallel to the Fuji volcanic zone and traverses the Izu islands. The second, branching from the first near Tanzawa Mountain, runs along the Miura peninsula, crosses the Uraga channel, and meets the third zone, which follows the line of the Yamiso Mountains, off the east coast of the Boso peninsula. These zones are so intimately connected that, when one is active the others also come into action. Mr. Shiratori remarks that observations of the earth-potential at Sendai show abnormally large variations during near earthquakes, those at the time of the great earthquake being very marked.

VOLCANIC ACTIVITY IN KILAUEA.—In his interesting account of the recent eruption of Kilauea, Dr. T. A. Jaggar remarks on the periodicity of the great eruptions of that volcano (Hawaiian Volcano Obs., Mon. Bull. for April and May 1924). These have occurred in the years 1790, 1823, 1855, 1887, and 1920 (the culminating year of the present cycle), the mean interval between successive eruptions being thus 32.5 years. For Vesuvius, about 33 years is a common interval, the last two eruptions having occurred in 1872 and 1906. "It would appear, and this agrees

with Omori's work in Japan, that 130, 65, and 32.5 years are intervals significant in volcanism." In the *Volcano Letter* for February 19, Dr Jaggar uses the percentage of dead cones in a district as an index of comparative volcanic activity in different Pacific regions (Sumatra, South Japan, the Fuji cross-zone in Japan, the Kurile Islands, the Tonga Islands, and the Hawaii Islands). He concludes that the extinction becomes less and the activity greater as we advance from the continental to the oceanic districts.

**OIL AND GAS POSSIBILITIES IN MONTANA.**—In a recent publication of the Department of the Interior, United States of America, we have a striking example of the value to a nation of highly organised geological survey, one that exists not only to amass and co-ordinate data of regional geology, but also to disseminate results and conclusions of contemporary economic import. In an area lying to the south of the Bearpaw Mountains, Montana, some little oilfield development had already been in progress, but had met with indifferent success; the United States Geological Survey accordingly sent Mr. Frank Reeves to investigate the geology and petroleum possibilities here, and the results of his survey are now available to the public in an excellent bulletin (751-C), one of high technical and literary merit. The author concludes that an area is favourable from a commercial point of view because the strata (*i.e.* Cretaceous) contain abundant organic material "of the proper kind to yield oil", further, that there has been sufficient, but not too much, regional alteration of the sediments to influence oil formation from this organic material; that there are suitable reservoirs of porous strata; that structures favourable to oil accumulation are present; that there has been no escape of oil by faults or as a result of flushing by circulating ground-water; that the character of the water found in one oil well sunk is favourable to the existence of oil, and that gas in commercial quantity has been located within the area. If geological advice can be of positive value in minimising risk of failure, here is a clear case where the chance is worth taking, though, as the author conscientiously remarks, "no one should invest money in the drilling of wells here unless he can afford to lose it." For the rest, the survey of this area shows it to be geologically typical of much of the north-central Montana country, characterised especially by its full Cretaceous development, its complexities of folding and faulting—the last factor of a somewhat unique kind in this area—and its abundant evidence (though not always on a commercial scale) of bitumen in one form or another.

**MINERALOGY OF FOSSIL BONE.**—The common belief that fossil bones are generally silicified is completely disproved by A. F. Rogers, who has thoroughly investigated a collection of 300 different examples ranging from the Ordovician to recent times, and gathered from widely separated countries in every continent. The evidence, which is convincingly set forth with numerous excellent photomicrographs in the *Bull. Geol. Soc. America*, vol. 35, pp. 535-56, 1924, shows that fossil bone consists almost entirely of the amorphous mineral collophane, which is also the principal constituent of phosphate rock. Collophane is not a definite chemical compound, but seems to be a hydrous solid solution of calcium carbonate (with smaller amounts of the fluoride and sulphate) in calcium phosphate. Corresponding to this the refractive index of fossil bone ranges from 1.573 to 1.621, though the smaller range, 1.595 to 1.615, includes the great majority of the specimens. The values show no regular relation to geological age. Bones seem to

become fossilised in a comparatively short time, and after that no further changes of importance take place. The collophane of fossil bone exhibits a feeble double refraction due to strain, and a thin section of the spine of a Permian reptile even displayed a distinct pleochroism from pale to deep yellow. This is probably the first record of pleochroism in an amorphous substance. Of all the specimens examined only three were found to be silicified. Various forms of silica, together with calcite, are commonly associated with collophane, but whereas the latter fills up the pores left by the removal of organic matter, and so preserves the structure of the bone, the associated minerals are usually merely the infillings of cavities. Thus it is found that the well-known opalised bones from White Cliffs in New South Wales are internal casts showing no organic structure.

**DEFINING IRON AND STEEL.**—The definitions of steel and cast iron as given by various authorities may be divided into two classes: (1) those based on the principal properties and methods of production of these materials; and (2) those based on the constituents present, *i.e.* on the carbon content. For example, steel is defined as an iron alloy which can be hardened by quenching or results from melting and is very tough, or is an iron alloy containing a certain quantity of carbon which when quenched is hard and elastic, etc. A definition based on the method of production is not really appropriate, for when a new method has been discovered, the definition has to be altered. The definition based upon properties is also inadequate, for the words "hard," "tough," and "elastic" are all relative. In a recent issue, Vol. 13, No. 2, of the *Science Reports of the Tohoku Imperial University*, Prof. Honda discusses this question and concludes that the only satisfactory definition is on the basis of composition. He defines steel as an iron carbon alloy with a content of carbon lying between 0.035 and 1.7 per cent. Cast iron is defined as an iron carbon alloy the carbon percentage of which lies between 1.7 and 6.7. The lower limit of 0.035 in the case of steel is chosen because, up to this amount, the carbon is retained in solid solution in the iron. These definitions take no account of the other constituents ordinarily present in steel and cast iron. While these may be regarded as immaterial in the case of steel, such is not the case for cast iron. However, Prof. Honda's contribution to the question is a step in the right direction.

**UNITED STATES ORDNANCE.**—The issue of the *Journal of the Franklin Institute* for March contains the address on modern ordnance delivered in September 1924 at the centenary celebrations of the Institute by Major-General C. C. Williams, of the United States War Department. It is devoted chiefly to the improvements which have been effected in the six years since the War, and shows that in almost every type of gun the range has been increased by about 50 per cent. at the expense of a small increase in weight. For sea-coast protection the guns are sixteen-inch and throw a projectile weighing more than a ton a distance of 27 miles. It has been decided that the long-range guns of the "Big Bertha" type are of doubtful value, as their work can be much more cheaply done by bombing aeroplanes. The demolition type of bomb has been considerably developed, and although a 4000 lb. bomb is under trial, it is believed that a 2000 lb. bomb will be the largest size needed. These bombs are timed so as to penetrate to the lowest story of a building or 40 to 60 ft. below the surface of the water before exploding. In this way the maximum effect is produced, and in the case of a ship greater damage is done by a near hit than by a direct one.

## Royal Meteorological Society.

THE Royal Meteorological Society was founded under the name of "The British Meteorological Society" on April 3, 1850, and the occasion of its seventy-fifth anniversary was celebrated in London on April 21 and 22. The following brief account of the history of the Society and of its predecessors may therefore be of interest.

The first English Meteorological Society was inaugurated so long ago as 1823. Luke Howard, Thomas Forster, and Dr. Birkbeck were among its founders, while Prof. Daniell was one of its members. The Society became dormant shortly afterwards, when Luke Howard moved away from London, and in 1836 a new Society was formed, which was generally known as the Meteorological Society of London. One of its members was John Ruskin, who in 1839 contributed to the Society's Transactions a paper from which the following extract is taken :

"A Galileo, or a Newton, by the unassisted workings of his solitary mind, may discover the secrets of the heavens, and form a new system of astronomy. . . . But the meteorologist is impotent if alone; his observations are useless, for they are made upon a point, while the speculations to be derived from them must be on space." The truth of these words is realised more forcibly to-day than ever before, and it is remarkable that they should have been written so long ago.

The 1836 Society developed pronounced astrological tendencies as time went on, and this fact appears to have led to the foundation of the present Society in 1850. Mr J. Glaisher, F.R.S., was secretary of the Society from 1850 until 1873, except during 1867-68, when he was president, and apparently his was the guiding spirit in the earlier years of the Society. The distinguished engineer Robert Stephenson, F.R.S., was president in 1857-58. Until 1866 the Society was a voluntary association of members, but in that year a Royal Charter of incorporation was obtained whereby members of the British Meteorological Society became fellows of the Meteorological Society. In 1882 permission was obtained from Queen Victoria to change the name of the Society to that at present in use, namely, the Royal Meteorological Society.

In conformity with the ideas expressed by Ruskin, the Society at first devoted itself to the expensive task of the collection and publication of meteorological observations from a number of stations, chiefly in England and Wales, as well as to the reading, discussion, and publication of original papers. For it will be recalled that in 1850 there was no State provision for meteorology in Great Britain. The results of this work are printed in the "Meteorological Record," which was published annually from 1881 until 1910. In 1911 the work was transferred to the State service, the Meteorological Office. Many investigations were undertaken by the Society in its corporate capacity, and brought to a successful conclusion; among these may be mentioned the collection of phenological observations from the area of the British Isles, and the annual publication of a phenological report in the Quarterly Journal of the Society. This enterprise is still vigorously pursued, the whole of the work of observation and compilation being voluntarily given. In 1919 the Scottish Meteorological Society, which had been founded in Edinburgh in 1855, was dissolved, and as many members of that Society as so desired were received as fellows of the Royal Meteorological Society.

The celebrations on April 21 and 22 took the form of (1) a visit to Kew Observatory, by invitation of the

Director of the Meteorological Office; (2) a conversazione in the rooms of the Society at 49 Cromwell Road, South Kensington; (3) an anniversary meeting, when a lecture on "Clouds and Forecasting Weather" was delivered by Prof. E. van Everdingen, president of the International Meteorological Committee and Director of the Royal Netherlands Meteorological Institute; and (4) a dinner at the Hotel Rembrandt. About 75 persons attended the various functions, and the guests included members of the International Commission for the Exploration of the Upper Air, who had previously held meetings at the Meteorological Office under the presidency of Sir Napier Shaw.

The visit to Kew Observatory during the afternoon of April 21 was much enjoyed, fine weather favouring the event. The visitors were shown over the observatory, and had the experience of witnessing the release of a registering balloon.

The conversazione on the evening of April 21 was held in the rooms of the Society and the visitors were received by Mr. C. J. P. Cave, president of the Society, and by Mrs. Cave. A number of exhibits, many of which had been lent for the occasion by fellows of the Society, were arranged, and Mr. F. J. W. Whipple showed a number of experiments, including the formation of halos, coronæ, and the green ray.

The anniversary meeting on the afternoon of April 22 was the principal event in connexion with the celebrations. The president welcomed the four honorary members who were present, namely, Prof. W. van Bemmelen, lately Director of the Batavia Observatory; Prof. E. van Everdingen; Prof. H. Hergesell, Director of the aerological observatory at Lindenberg; and Prof. Th. Hesselberg, Director of the Norwegian Meteorological Service and secretary of the International Meteorological Committee. The president then read a telegram which had been sent to His Majesty the King, patron of the Society, and the reply from His Majesty, which concludes: "The King rejoices in the thought that recent years have seen important advances in the science, and he earnestly trusts that the Society will be able to record still further developments in their valuable and interesting labours." Afterwards a number of addresses of congratulation were read from foreign meteorological institutes and other scientific bodies, and from a number of private persons, including a letter from the venerable Prof. H. Hildebrandsson of Upsala, foreign member.

Prof. E. van Everdingen then delivered his lecture on "Clouds and Forecasting Weather." He said that failure to forecast the weather 24 or 36 hours ahead can be ascribed to lack of suitable observations, among which are those of the motion of high and medium clouds. He showed an example of the improvement in the forecasts which would have been produced had cloud observations been available, and put forward a strong plea for the regular observation and transmission of information regarding cloud motion. The methods of the "weather-wise," who use only local observations to foretell coming weather, are ill-defined, but it is not difficult to account for many of their maxims in the light of modern knowledge, as derived from aerological research and the observation of clouds from aircraft. The main object of cloud-observation for the professional forecaster ought to be to tell him something definite of the atmospheric conditions in the upper air over the whole area of his map. Inversions of temperature usually occur over cloud-sheets, and if the latter are identified at a number of stations, the horizontal

extent of the inversion is defined. Such inversions tend to prevent upward convection and the formation of rain is hindered. Complete observations of halo would be of material assistance. At de Bilt in 1922, rain followed halo in 70 per cent. of cases of halo observations, and only 70 out of 200 rain-days were not preceded by halo observations somewhere in Holland.

The anniversary dinner was held on the evening of April 22. After the toast of the King, patron of the Society, had been enthusiastically honoured, Mr. H. Mellish proposed the toast of The Services, and Capt. H. P. Douglas, Hydrographer of the Navy, responded. He spoke of the work which is now being done in the

Navy in the investigation of the upper air by pilot balloons and registering balloons. Sir Philip Sassoon, M.P., Under-Secretary of State for Air, proposed the toast of the Royal Meteorological Society. He referred to some of the events in the history of the Society, and paid a tribute to the aid which meteorologists had been able to send to the Airship R33, in the shape of weather reports and directions for the best course to be taken, on the occasion of its recent break-away in a gale from its mooring-mast at Pulham. The president responded to this toast. Sir Napier Shaw proposed the toast of International Meteorology, and Prof. E. van Everdingen responded.

R. C.

### The British Science Guild.

THE annual meeting of the British Science Guild was held in the Salters' Hall on Tuesday, April 21, the chair being taken by the Right Hon. Lord Askwith, president of the Guild.

Reviewing the work of the Guild, the chairman directed attention particularly to its co-ordinative functions, linking together the operations of many different bodies, and to its efforts to bridge the gulf between men of science and the general public. Reference was made to the issue of the revised edition of the Catalogue of British Scientific and Technical Books, which now contains more than 9500 titles of books, and should prove most valuable to students, libraries, and manufacturers. Methods of obtaining "Science Publicity" are being considered, but this demands the co-operation of leading scientific and technical societies. A new feature has been the formation of six standing committees (National Security, Parliamentary, Health, Research and Industry, Finance, and General Purposes).

An address emphasising the need of increasing knowledge of science among the public, and the application of scientific method to public affairs, was delivered by Sir William Bragg, who pointed out the contrast between the marvellously rapid development of scientific data, and the meagre facilities for letting the public know what was being done on their behalf. The forty millions of people in the British Isles are living on the direct application of science, and they should know what science has done, and what it might do in the future. It is unfortunate that scientific men, who spend their days in wresting information from Nature in the laboratory, have not as a rule the

supplementary gift of conveying scientific information in a popular form. Publicity for science is needed. If, as it is hoped, a proper organisation for publicity in scientific matters could be created, there should be at its head a scientific literary man, and behind it funds sufficient to tide over the first period of its existence.

Sir Arthur Newsholme, speaking as chairman of the Health Committee, said that the average life of a child born to-day is some 10 to 12 years longer than it was 30 to 40 years ago. This is due to a better knowledge of the laws of health. What should be investigated are the causes of evils rather than their alleviation—as illustrated by the millions of headache powders and similar nostrums sold. Attention has been directed by the Health Committee to two defects in the Births and Deaths Registration Bill now before Parliament. There is no valid verification of the fact of death, and the certificate of death should be regarded as confidential and lodged with the registrar and not handed to the nearest relative.

Major the Hon. H. Fletcher Moulton (chairman of the Research and Invention Committee) pointed out that in regard to industry there is a gap similar to that remarked on by Sir William Bragg in connexion with publicity. Manufacturers of Great Britain are sometimes blamed for not availing themselves more freely of the results of scientific researches. There is, however, a gulf between the man working in the laboratory and the business man. An intermediary, who could demonstrate to the latter how he would benefit from the application of science, is needed. It is in this intermediate stage that Germany has made such rapid progress.

### Excavations at Cresswell Crags, Derbyshire.

AT a meeting of the Royal Anthropological Institute held on April 21, Mr. A. Leslie Armstrong read a paper entitled "Recent Excavations on Palæolithic Sites at Cresswell Crags, Derbyshire," describing excavations which had been carried out by him under a Joint Committee of the British Association and the Royal Anthropological Institute. The two important sites of Upper Palæolithic date under investigation consist of a rock shelter and a cave respectively. The former, excavated between June and October 1924, is situated in front of Mother Grundy's Parlour, the last cave of the Cresswell group excavated by Sir William Boyd Dawkins and the late Rev. J. M. Mills in 1879. This proved to be an undisturbed stratified deposit with a Palæolithic relic bed 2 feet 6 inches thick. The lowest stratum yielded implements of quartzite which, from evidence afterwards obtained in the cave site, are probably referable to Mousterian times. Overlying this was a rich deposit from which flint implements, bone tools, and

three pieces of engraved bone were recovered. The latter are believed to represent bison, reindeer, and rhinoceros, but all are fragmentary. At the lowest level of this layer was a hearth formed in a hollow scooped out in the basement bed and ringed around with flat stones, on edge, just as Boy Scouts build a fireplace to-day. The area around the fire proved the most prolific in antiquities. The flint implements from that level are late Aurignacian in general character, those from the top of the deposit are early Tardenoisian, and those from the intervening layer reveal a gradual development in style and technique from one culture to the other.

The second site dealt with was the cave known locally as the Pin Hole. Excavations in September last revealed that the examination made by Mills fifty years ago had extended to the first seven yards only, and that the remainder of the cave was practically undisturbed. Through the generosity of the Percy Sladen Memorial Fund Trustees and the kindness of

His Grace the Duke of Portland, it has been made possible to undertake a thorough examination of the cave, and work is now in progress there. The results already achieved include the discovery of a lance point in mammoth ivory, engraved with a conventional pattern, which is assigned by the Abbé Breuil to the Middle Magdalenian period, and is identical with one found in the cave of La Madeleine itself. This implement and others associated are considered to provide the most definite evidence so far discovered at Cresswell for the precise dating of the culture and its correlation in point of time, if not in development, with the classic cave sites of France. Considerable data have also been obtained in proof of occupation in Upper Mousterian times and at a still earlier period.

At the conclusion of the paper a letter was read from Sir William Boyd Dawkins, chairman of the Committee, in which he entered a *caveat* against acceptance of the engravings on bone from Mother Grundy's Parlour as of human origin. In his opinion, they were due to the action of roots. In the discussion, Prof. W. J. Sollas said that he had no doubt that they were of human origin, while Miss Garrod stated that she was authorised to say that the Abbé Breuil, who had examined the fragments that day, was convinced that the reindeer, and some at least of the lines forming the figure which was thought to be a rhinoceros, had undoubtedly been engraved by man. The bison, however, was more doubtful and might possibly be due to root action.

### The Natural History of Disease in Baltimore, Maryland.<sup>1</sup>

THE publication before us forms one of the admirable reports issued by the Carnegie Institution of Washington, and therefore calls for attention. It purports to trace the development of public health in one of the oldest cities in the States, and to correlate, so far as practicable, the ascertainable factors bearing on the natural history of disease in that city during a span of more than a century. The attempt is made in nearly 600 pages, beset with elaborate statistical tables and a number of graphs, which have been reduced to an extent which makes them partially illegible.

The valuable portion of the work deals with the actual topography of Baltimore and with the details of the gradual development of its public health administration. In 1820 an ordinance was passed making it the duty of all practising physicians to report cases of malignant or contagious fevers to the mayor or Board of Health; and although this and subsequent but very early further ordinances of similar nature were not enforced, they are interesting as preceding by many years similar ordinances (which were enforced) in Great Britain. Similarly, health commissioners, corresponding to our medical officers of health, were appointed, antedating the appointment of the similar earliest appointed officers in London and in Liverpool. But although these appointments were made, the rapid growth of Baltimore, its increasing heterogeneity of population, and other factors, have left it far behind in subsequent sanitary practice. The reader will find, in comparing the Baltimore enactments with those in Great Britain, much of interest and of practical value; and the balance to the good does not always rest with English legislation. Perhaps, however, we may agree with Solon in his advice to the Athenians; let us have the

best law we can keep, not the best laws that can be made.

For epidemiologists and students of natural history generally, however, one looks chiefly to the history of disease prevalence as here presented. A vast amount of material has been compiled, Teutonic in bulk, and Teutonic likewise in the failure to sift out what is trustworthy and to save the student unnecessary and wearisome detail. Thus deaths and death-rates are given for all causes in the aggregate and for some single diseases from 1812 onwards, although prior to 1875, when death-certificates were first required by law, the only information available was that obtained from the sextons of the cemeteries. What proportion of deaths were buried "extra-murally" we can only guess, but the large extent to which deaths of inhabitants in institutions outside the city—which are not recorded in the city statistics—vitiates the statistics given throughout the report, may be gathered from data emerging here and there in the volumes.

When we pass to causes of death, difficulties in accepting the data laboriously collected begin to multiply. Thus on p. 193 is given a list of the causes of deaths named among the burials in the year 1819. "Consumption" is the only item of likely tuberculous nature which appears. On p. 383 the death-rate from pulmonary tuberculosis for the same year appears as 492 and from other forms of tuberculosis as nil. In 1920 the corresponding rates were 128 and 23<sup>1</sup>. On such data, of which an extreme example has been given, are based discussions as to the upward and downward course of the tuberculosis death-rate, which possess very slight value. The problem in Baltimore, as in many other American cities, has been complicated by large immigration of Irish, of Greeks, of Russians and Poles, and by a large negro population. The statistics deal with these heterogeneous groups as if they formed a homogeneous whole; and on such data, extremely imperfect in other respects, we are asked to accept sweeping conclusions, as for example that the course of the death-rate from tuberculosis in Baltimore has been determined above all other factors by natural selection. On similarly imperfect data, to give one further illustration, is based the unlikely inference that although an increasing ratio of the population now attain middle life, these individuals on the whole prove to be poorer risks and less capable of survival to old age than were the proportionally smaller numbers who reached the age of 40 "when natural selection was more searching in its action." To base such a sweeping conclusion on the imperfect statistics of a heterogeneous population, affected by immigration, composed of blacks and whites, of persons of eastern and southern European as well as of British and Irish origin, is extremely indiscreet, and study of the English Registrar-General's figures would have shown its error for a country in which more stable conditions exist, and for which official mortality statistics can be regarded as trustworthy.

### University and Educational Intelligence.

CAMBRIDGE.—Mr. H. Gilbert-Carter, Trinity College, has been reappointed as curator of the Herbarium. Sir John Russell and members of the staff of the Rothamsted Experimental Station are giving this term a special course of lectures on "The Chemistry, Physics and Biology of the Soil." The Linacre Lecture will be delivered on May 6 by Lt.-Gen. Sir William B. Leishman, Director-General, Army Medical

<sup>1</sup> Public Health Administration and the Natural History of Disease in Baltimore, Maryland, 1797-1920, by Dr. W. T. Howard, jun.

Services, on "Health in the Tropics: the Present and the Future."

An appointment is to be made in July of the Busk Studentship for research in aeronautics, and specially in those subjects such as stability problems, meteorological questions bearing on flight, or the investigation of gusts, treated either experimentally or mathematically, in which Edward Busk was specially interested. The Studentship is of the value of about 150*l.*, tenable for one year from October 1, and is open to any man or woman being a British subject and of British descent who had not attained the age of twenty-five years on October 1, 1924. Application forms, to be returned not later than May 12, can be obtained from Prof. B. M. Jones, Engineering Laboratory, Cambridge.

GLASGOW.—The degree of Doctor of Science (D.Sc.) has been conferred on Mr. F. Y. Henderson for a thesis entitled "An Apparatus for the Study of Transpiration under Controlled Conditions."

THE Yorkshire Summer School of Geography will be held at Redcar during the fortnight August 8-22, providing the number of entries is sufficient. The School is intended to provide a "refresher" course for teachers of geography which will help them to keep in touch with recent developments, and will include lectures, practical work, discussions, and excursions. Lectures will be given on the principles of human geography, economic and regional geography, the teaching of geography, and on climate. Practical work will include the analysis and study of topographic maps and the elements of survey. Applications for tickets should be made, not later than May 11, to the Secretary of the Yorkshire Summer School of Geography, the University of Leeds.

THE "Spirit of Modern Science Instruction" is discussed in a thoughtful article by Director O. W. Caldwell of Lincoln School Teachers' College, New York City, in the January number of *School Life*, the organ of the United States Bureau of Education. During the past fifteen years dissatisfaction with excessive specialisation in secondary schools has led to the development, after much careful study and experiment, of a type of "general science" course which has been widely adopted. Returns for 1921-22 show that in 13,700 public high schools there was an enrolment of approximately 400,000 students in general science. The success of this type of course has been achieved in many schools without any diminution of the numbers enrolled in the physics, chemistry, zoology, botany, and physiology classes, and has changed beneficially the character of the work done in these sciences. The point, however, to which the article chiefly directs attention is not so much the importance of science teaching being efficient as the importance of cultivating in the young an appreciation of the proper use of science in modern life, and a determination to make it subservient to the general welfare. "Until people do not wish to destroy their enemies or their competitors they must not possess the means or knowledge for doing so. Science courses for all the people must help all the people to interpret science for service, not science for power." To considerations such as these are partially attributable, no doubt, the remarkable efforts that are being now made in the United States in connexion with the "Education Week," and otherwise to promote instruction and training in good citizenship.

### Early Science at Oxford.

May 3, 1687. An account of ye Solar eclips, May ye 1st 1687, was communicated by Mr. Caswell. The Dublin Minutes from Nov. 15 to April ye 7th were read, speaking of a new Engin invented by Mr. Ash to raise water with an inconsiderable Power. They communicated a farther account of ye petrifying of Lough Neagh;—that a toad was kept for eight mounths in Dublin, notwithstanding ye Opinion that noe venomous creature would live there;—that hares and rabbits grow white by Snow;—that Partridges are generally white on ye Alpes.

A discourse was given in to the Society, being a confirmation of Dr. Moline's Observation of ye communication between ye ears of Birds, by Mr. Pitt.

May 4, 1686. A Letter from Mr. Grail, Rector of Lassington near Gloucester, was read, wherein he gave an account of the little stones called *Asterna*, found chiefly in his Parish, which being put in Vinegar, will move towards one another: if they lie long in vinegar they will wast away, but will keep their starre-like figures notwithstanding their diminution.

May 5, 1685. A Letter from Mr. Will Molyneux gave an account of a new Hygroscope of his invention: it is made of common whip-cord fastened at ye upper end: the lower end hangs loose with a little weight annexed, and turnes round according to ye degree of moisture in ye Air: the turning of ye lower end is mark'd by a tongue or index joyned to ye weight, and playing over a circle in paste-board or ye like, so as that ye weight hangs over ye centre of ye circle.

May 6, 1684. Dr Plot was pleased to oblige us farther, with ye sight of a Glow-worm shining in ye middle of ye day. This gave occasion to some discourse concerning Lucid Animals; in which Dr. Bathurst bore a considerable share, affirming, that, in some dissections of Glow-wormes, he had formerly observed, that as soon as ye Insect was cut in peices, ye lucidity disappeared; but it was asserted that even ye peices of a dissected Glow-worm have been known to shine; ye Doctor mentioned ye bones of a Thornback, as remarkable for lucidity.

The Mercury of ye Barometers, haveing been very low, all ye last weeke, and no rain near Oxon, gave susption that there might be rain at some distance: ye like event haveing been certainly known about a month since. This discourse began on ye account of a scheme of ye weather ye last month, taken, and communicated, by Dr. Plot.

1690. A Project of making all ye high-ways and streets perfectly good and smooth at ye charge of what 3 years expence as ye present amounts to; after which they may be kept in repair for ever with very little charge or trouble by the use of rollers instead of wheels.

May 7, 1686. The Minutes of the Dublin Society from Feb. 22 to April 26 were read. They gave an account that encouragement being given by ye Lord Lieutenant for forming that Society into a body corporate by the procurement of a Charter, subscriptions for money towards it were made by several.

Mention being made in those minutes of a place between the Tropicks where the *Shadow* goes twice forward upon the dial, and twice backward in a day, Mr. Caswell sayd that this thing happens some parts of the year in all places between the Tropicks (except under the Equinoctial) upon a horizontal dial, and in other places that are not in the torrid zone, upon an inclining dial.

## Societies and Academies.

## LONDON.

**Association of Economic Biologists.**—The following were among the papers presented at the Edinburgh meeting on February 26 and 27:—

February 26.—F. A. E. Crew: Intersexuality in fowls and pigs. The condition in fowls is classified as (a) those in which a functional ovary occurs on the left and an active testis on the right; (b) ovotestis on left and active testis or no gonad on the right. The first condition is due to lack of inhibiting power in the ovary, so that the other gonad develops. It is always male. In the second class, there is ovarian disease or some other cause for the change of tissue.—W. G. Smith: The relation between hill pasture and sheep grazing. Work carried out at Boghall Farm, lately acquired by the Edinburgh and East of Scotland College of Agriculture, has shown a definite relationship between herbage and the quality of sheep produced. The value of the herbage varies with the nature of water supply. When the water is entirely aerial, the soil is impoverished and acid, and grazing is limited mainly to young growth in early summer. When the herbage is flushed by springs, the soil is less acid, and grazing is continuous. The most constant grazing of sheep is in moist places responsive to phosphates, as shown by the increase of white clover and pluff grass.—W. Robb: Hybridisation of oats. Experiments conducted with the view of improving the technique of hand-pollination in oats. Oats are generally self-fertilised and natural hybrids are rare. In a number of pure line cultures of known varieties grown side by side for years, only one hybrid was secured. Oats do indeed flower freely, but apparently *after* self-pollination has taken place. A wide range of artificial hybrids has been secured, but none between *Avena strigosa* and any of the cultivated oats. A difference in the chromosome numbers may explain this failure.—J. W. Gregor: Observations on the physiology of reproduction in some agricultural grasses. The work was carried out by the use of paper bags in greenhouses and specially designed pollen-proof boxes in the field. More than 90 per cent. of plants in both Italian and perennial rye grass were found to be self-sterile, and the self-fertile fraction are probably not self-pollinated. A proportion of this self-sterility is due to lack of pollen, only the female organs being developed.—J. M. F. Drummond and F. W. Sansome: The improvement of swedes and turnips by breeding. Yield and quality are of primary importance, but keeping quality and resistance to finger and toe disease are also important. Problems of testing yield in small field plots and feeding value by chemical analysis have yet to be solved. The value of the "dry matter" percentage as a criterion of feeding value is being reinvestigated. The policy of the Scottish Plant Breeding Station has been that of line selection (pure line method). In beginning work, 1922, strains approximately homozygous in respect of important characters were selected. A number of characters in swedes and turnips proved to be inherited, and enough evidence is at hand to show the possibilities of line selection for the improvement of these roots.—J. Ritchie: The control of mussels in sea water-pipes. The method used to prevent the blocking of the pipes at Portobello Electric Station with mussels and other marine growths was described. The problem was serious, for during the five months of maximum growth a layer 2-3.5 inches thick formed inside the 5-foot feed pipe. The water taken in was

used in the condensers, and it was found that by raising the temperature, in vacuo, of water that had just been used and returning it through the feed pipes, the growth could periodically be killed and prevented from assuming obstructive proportions.

February 27.—R. S. MacDougall: The ox warble flies and their control. Warble flies (*Hypoderma* spp.) are the cause of a great annual loss in Great Britain alone to farmers, butchers, and particularly hide and leather merchants. Great success has attended the attack on the larvæ in their last instar, when lying in a swelling on their victim's back. From 82 to 90 per cent. can then be killed by (1) tobacco powder and lime, (2) Derris, or (3) sulphate of nicotine, in various proportions.—P. H. Grimshaw: The occurrence in Britain of *Hydrellia griseola*. In Britain this fly does no damage though it is widespread, but round the Baltic it has been for a long time a serious pest of barley and oats.—Malcolm Wilson: (1) *Rhizosphaera kalkhaffi* causing disease of spruce firs. The fungus is widespread in Central Europe and has lately been discovered frequently in Britain on the glaucous varieties of *Picea pungens*. Needles of the spruce become pale and purplish and fall off. Stem, etc., become blocked by spores. The disease also attacks Sitka spruce and (on the continent) the Norway spruce. It is spread by spores. (2) The occurrence of *Tuberculina maxima* in Scotland and its effect on the blister rust of the Weymouth pine. Blister rust is so serious a disease of the 5-needled pines in Britain that their planting has practically ceased. *T. maxima* is a parasite of the blister rust, and it has now been found for the first time in Britain. On the continent *T. maxima* does not apparently entirely kill out the rust, but there are indications that under the different weather conditions prevailing in Britain, the parasite may have greater value as a control.

**Institute of Metals.**—The following were among the papers presented at the annual general meeting held on March 11 and 12.

March 11.—H. T. Angus and P. F. Summers:—The effect of grain-size upon hardness and annealing temperature. Many heavily worked metals increase in hardness on annealing for a short time at relatively low temperatures, and this property depends, among other things, upon the grain-size that existed at the time of rolling. A coarse grain-size increases this rise in hardness and the range of temperature over which it extends, whereas with a fine grain-size, softening may commence at much lower temperatures. This effect was noted in both pure copper and bronze containing 4.5 per cent. of tin. The recrystallisation temperature of copper is higher in the coarse-grained metal than in the fine-grained. By calculating the area of grain boundary per cubic millimetre of metal from the grain-size, and plotting against hardness, a straight line was obtained, indicating that the hardness varies directly with the area of grain boundary per unit volume of metal.—S. L. Archbutt: A method of improving the properties of aluminium alloy castings. The process consists in allowing the molten alloy or metal to cool slowly in the crucible in the furnace until it has just completely solidified; it is then remelted, and may be carefully stirred, raised to the pouring temperature, and cast. Ingotting the metal is not satisfactory, as the ingots cool too quickly, and during remelting are too much exposed to the furnace gases. Passage of an inert gas through the melt during slow cooling and solidification improves still further the soundness of resulting sand-cast bars. The method eliminates a

considerable proportion of dissolved gas and thus reduces unsoundness, and to a considerable extent removes pin-holing.—Ulick R. Evans: Surface abrasion as a potential cause of localised corrosion. Previous work has indicated that most cases of serious corrosion are of an electrochemical character; it has been suggested that very severe corrosion may be occasioned by electric currents flowing between a bare abraded portion and the still encrusted area. An experimental investigation has been made regarding the existence of these currents. Sometimes they flow in such a direction as to localise corrosion on the small abraded portion, sometimes in the contrary direction. But they are generally transitory, dying away soon after abrasion ceases. Moreover, the abrasion required to produce them must, in most cases, be sufficient to damage the metal by mechanical erosion also. In the corrosion of zinc by hydrochloric acid, the wiping away of the black scum of residual impurities (lead, etc.) actually diminishes the rate of attack. Commercial (impure) zinc is attacked more slowly than some grades of much purer zinc. Probably "homophase" impurities (in solid solution) behave in the opposite mode to "heterophase" impurities (present as a separate phase).—J. Newton Friend and J. S. Tidmus: The influence of emulsoids upon the rate of dissolution of zinc in solutions of lead, nickel and copper salts. Emulsoids tend to retard the velocity of such reactions, whether chemical or physical, as involve a change of state from solid to liquid, or vice versa, in one or more of the components. This retardation is, in the main, due to adsorption; a thin layer of the emulsoid collects upon the surfaces of the solid reactants and impedes their chemical activity. The retarding action frequently falls off markedly with rise of temperature.—Denis Bunting: The influence of lead and tin on the brittle ranges of brass. The chief effect of lead is mechanical; the brittle range in itself is not affected, but masked owing to the embrittling effect at other temperatures of the lead which segregated as globules at the grain boundary. Tin in excess of the solubility limit produces extreme brittleness owing to the production of the brittle gamma or delta constituent. The effect of tin in solution appeared to be connected with an increase in crystal rigidity.

March 12.—G. L. Bailey and R. Genders: The density and constitution of the industrial brasses. A reduction of density, due to unsoundness accompanying constitutional change ( $\beta$  to  $\alpha$ ), occurs in the brasses over a considerable range of composition. The unsoundness is removable either by reversing the constitutional change (as by quenching) or by mechanical compression. Thus heat-treatments, involving quenching of the  $\alpha$   $\beta$  brasses and a small range of the  $\alpha$  brasses, may give rise to internal stresses of considerable magnitude. The cracking of heat-treated articles which sometimes occurs appears to be attributable to constitutional volume change rather than to the difference between the expansivities of the different constituents.—A. L. Norbury: Note on the effects of certain elements on the electrical resistivity of copper. Values for the increase in the electrical resistivity of copper due to the presence in solid solution of 1.0 atomic per cent. added element are calculated for each of the added elements. The "atomic effects" are small for elements like silver and gold—which are in the same group as copper in the Periodic Table—and are progressively larger as the added elements are farther away from copper in the Table.—Sir Thomas Kirke Rose: On the density of rhodium. One specimen

was forged up from sponge and annealed but not melted, and the other melted from sponge in the oxyhydrogen blowpipe and forged while hot. The rhodium sponge was chemically pure. The density of the melted specimen was 12.47 in vacuo at  $0^\circ/4^\circ$ , but the other specimen was evidently not free from internal cavities, as its density was only 12.22. Previous determinations have given 12.1–12.6.—Kotaro Honda and Ryonosuke Yamada: Some experiments on the abrasion of metals. In soft metals and carbon steels the amount of wear is proportional to the frictional horse-power, provided that the coefficient of friction is constant. Under a constant frictional horse-power the amount of wear increases with the coefficient of friction. The effect of the velocity of abrasion on the amount of wear is negligibly small in the range of velocity investigated.

## PARIS.

Academy of Sciences, March 23.—A. Haller and Salmon Legagneur: Diketones and mixed ketones derived from the  $\alpha$ -mono-nitrile of camphoric acid and of methyl cyanocampholate.—A. Desgrez and R. Vivario: The estimation of carbon in organic substances. The wet combustion method (sulphuric acid and potassium bichromate) with addition of a short length of red-hot copper oxide is employed. Tubes of potassium ferrocyanide and borax are used to remove chlorine and hydrochloric acid. Test analyses are given.—G. Claude: The rectification of the light in neon tubes. If the Geissler tube is made up of a series of wide and narrow sections, the wide portions show the mercury spectrum only and the narrow the neon spectrum.—G. Friedel: Ethyl anisal-*p*-aminocinnamate.—Henry Scott was elected corresponding member for the section of botany.—Bertrand Gambier: Generalisation of the remainder theorem of Brill and Noether. Application to groups of superabundant points.—Alexandre Kovanko: The necessary and sufficient conditions for the summability of some functions.—V. Weniaminoff: Some properties of the limit derivative.—P. Clerget: Reconstitution of the explosion motor of 1806 of the brothers Niepce. At the instance of the Service technique de l'Aéronautique, this early internal combustion motor has been reconstructed and found to work perfectly, using lycopodium powder as the combustible.—Rateau: Remarks on the preceding communication.—Barrillon: Resistance to the passage (through water) of cylinders of revolution turned in a sense perpendicular to their axis.—Lémeray: Spherical clusters. The theorem of level surfaces.—La Rosa: The relation between colour and amplitude of the variable stars and the ballistic theory. Reply to some criticisms by Ch. Nordmann and C. Le Morvan.—Le Roux: The determination of the viscosity coefficient of water in absolute value. The rotating cylinder method was adopted in preference to the capillary tube. Absolute viscosities are given for  $5^\circ\text{C}$ . intervals between  $0^\circ\text{C}$  (0.0178) and  $50^\circ\text{C}$ . (0.057). The results are in good agreement with those of Thorpe and Rodger.—G. Reboul: Study, under reduced pressure, of the radiation emitted by highly resistant bodies traversed by an electric current.—G. Foëx: The various magnetic states of an ion. Two specimens of a pure salt (Mohr's salt), well defined from a chemical point of view and placed under identical conditions, may present very different magnetic properties, apparently corresponding to distinct structures of the paramagnetic ion.—E. Darmon: The action of boric acid on the rotatory power of malic acid and the malates. The existence of complex compounds of boric and malic acids is clearly

proved; some definite lævorotary compounds of ammonium, sodium, and aniline have been isolated, but the complex dextrorotary compounds are less stable, and, at present, have not been isolated.—P. Lambert and D. Chalonge: A self-recording microphotometer with a photo-electric cell. The current from the photo-electric cell is amplified by a triode valve, under conditions securing stability and proportionality. As an example of its use, a negative of the ultra-violet spectrum of the sun is given.—A. Couder: The action of ammonia on cyanamide.—P. Job: The spectrographic study of the formation of complexes in solution and their stability.—L. Hackspill and R. Grandadam: The reduction of the metallic oxides by the alkaline cyanides. A repetition of Liebig's experiments (1842), using pure sodium cyanide (98.5 per cent.) and working in a vacuum. The oxides of lead, tin, copper, and iron give the metal, carbon, carbon monoxide, carbon dioxide, nitrogen, and metallic sodium, the weight of the sodium being practically equivalent to that of the reduced non-volatile metal. Strontium and barium are also reduced and combine with the metallic sodium to form a volatile alloy.—Mlle Suzanne Veil: The decomposition of hydrogen peroxide in the presence of nickelous hydroxide. Nickel hydroxide decomposes hydrogen peroxide with evolution of oxygen, but no higher oxide of nickel is formed. The study of the changes in the coefficient of magnetisation shows that nickel hydroxide is not a true catalyst, if the latter be defined as a substance which remains unchanged throughout the reaction. Curves are given showing the changes in the magnetisation coefficient as a function of the time of exposure to the hydrogen peroxide solution.—Delbart: Contribution to the study of cold-drawn steels.—Ch. Jacquet: The constancy of the yield of the cold spring Velléda of the Royat thermal establishment. The hourly yield of this spring (10,210 litres) has not changed since 1886, and is independent of external meteorological conditions.—Emm. de Martonne and L. Aufrère: Extension of the oceanic drainage.—F. Lœwinson-Lessing and V. Mitkewitch: The natural and artificial permanent magnetisation of rocks. A method is described capable of distinguishing between permanent magnetisation produced by lightning and that produced by the terrestrial magnetic field.—Henry Hubert: The quasi-permanence of the shape of the meteorological curves in Western Africa.—Pierre Lesne: The fauna of the peaty alluvium of the Seine valley to the south of Paris.—René Souèges: The embryogeny of the Hypericaceæ. The development of the embryo in *Hypericum perforatum*.—A. Guilliermond: New observations on the structure of the Cyanophyceæ.—J. Nageotte: The extreme contraction resulting from freezing striated muscle in the frog.—Ch. Champy and N. Kritch: Analogy of the hormone action of the male and female genital glands on the crest of the Gallinaceæ.—Marcel Avel: The vacuome and apparatus of Golgi in the vertebrates. The vacuoles, whether pre-existing or not, which take up neutral red and other stains are, at least in vertebrates, independent of the apparatus of Golgi.—René Jeannel: The morphology and origin of the claw of the tarsus of insects.—Jacques Risler and Paul Mondain: The limit of the antagonistic action of the spectrum and the application of radiations of great wave-length to the treatment of radiodermatitis and neoplasms.—René Fabre: A new method for the extraction of alkaloids or of various organic substances contained in the organs. The organ in a fine state of division is submitted to the digestive action of pancreatine for 12 hours at 50°–55° C. After filtration, the filtrate can be extracted with suitable

solvents. Substances such as strychnine, narcotine, veronal, sulphonal, atropine, cocaine, and morphine are stable towards the ferment, but the possibility of the pancreatine acting on the substances sought for must not be forgotten. Compared with the classical Stass-Otto method the process suggested gives higher yields in less time.—A. Goris and M. Métin: The presence of two alkaloids in *Aconitum Anthora*.—N. Bezssonoff: Some data on the nature of the antiscorbutic principle known as vitamin C. A new process for extracting vitamin C from cabbage juice is described. The crystalline product obtained was analysed (carbon, 45.6 per cent.; oxygen, 48.2 per cent.; hydrogen, 6.2 per cent.). Daily doses of less than 2 mgrm. of this product prevented scurvy in guinea-pigs.—C. Gessard: Pyrocyanoid bacilli of the melanogen variety.—Léon Blum, Maurice Delaville, and van Caulaert: The relations between the physico-chemical state of the body fluids and the phenomena of ossification and decalcification.

#### ROME.

Royal Academy of the Lincei, February.—G. Arturo Crocco: The degradation of wealth.—Secondo Franchi: Observations on the large overthrust Ausonio-Lepino.—Giulio Supino: Elastic systems in two dimensions and their relationships to spacial deformation.—Enrico Fermi: Intensity of multiple lines.—Francesco Rizzi: Rotatory power of fluorinated derivatives of benzene and its homologues as a function of the wave-length.—P. Bertolo: Action of iodine on desmotroposantonin; Artemisic acid.—Luigi Sanzo: Ova and larvæ of *Alalunga* (*Orcynus germo* Ltkn.).—Roberto Savelli: Transmission of mutations through interspecific hybridisations: Statistics of the first series of experiments.—Nazareno Strampelli: Acquisition of new characters in the glumes of blind and eared wheats (*Triticum folliculosum*).—S. Mandelbrojt: Generalisation of the calculus of variations.—F. Sbrana: An integral equation occurring in the statistical theory of the photo-electric effect.—A. Carrelli: Certain effects produced by rotatory motions.—Mentore Maggini: Aspect of the spots on Mars observed at Catania during 1924.—Francesco Vercelli: The results obtained during the cruise of the *Marsigli* in the Straits of Messina. The investigations on currents are described.—Washington Del Regno: Transformation or nickel in the neighbourhood of the Curie point. The temperature at which nickel begins to undergo transformation varies with the physical phenomenon considered. Apparently certain properties exhibit variation as soon as even a small part of the metal passes from one state to the other, whereas others vary only when an appreciable proportion of the material has suffered change.—Giuseppe Stefanini: First geological results of the mission of the Royal Italian Geographical Society to Somaliland, 1924.—G. Rodio: Pigments of the Florideæ.

#### Diary of Societies.

SATURDAY, MAY 2.

ROYAL SOCIETY OF MEDICINE (Otolaryngology Section) (Annual General Meeting), at 10.30.—A. Cheate: The Mastoid Emissary Vein and its Surgical Importance.

ROYAL INSTITUTION OF GREAT BRITAIN, at 8.—W. P. Pyrcraft: Use and Disuse and their Effect on the Bodily Structure of Animals (II.).

MONDAY, MAY 4.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory), at 4.30.—R. H. Fowler: A Theoretical Study of the Stopping Power of Hydrogen Atoms for  $\alpha$ -particles.—Dr N. Bohr: On the Interaction of Atoms

during Impacts.—K. G. Emeléus: The Action of the Electrical Counter.—R. A. Fisher: Theory of Statistical Estimation.—W. Burnside: (a) On the Idea of Frequency; (b) On the Representation of the Modular Group of Order.—J. P. Gabbatt: On Pedal Quadrics in Non-Euclidean Hyperspace.—F. P. White: An Extension of Wallace's, Mignuel's, and Clifford's Theorems on Circles.—Prof. H. F. Baker: (a) The Stability of Rotating Masses of Liquid; (b) Note on a Formula for Lane Functions.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Prof. E. Naville: Paper.

ROYAL COLLEGE OF SCIENCE ASSOCIATION (at Royal College of Science), at 5.—Prof. E. B. Poulton: Thomas Henry Huxley (Huxley Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—R. C. S. Walters: Water Power Exhibits at the British Empire Exhibition, Wembley, 1924.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. J. Laird: The Nature of Ideas.

ROYAL SOCIETY OF ARTS, at 8.—Prof. J. S. S. Brame: Motor Fuels (Howard Lectures) (III.).

SURVEYORS' INSTITUTION, at 8.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.15.—J. E. Hackford: Gas Production from Heavy Oils by Partial Combustion.

ROYAL SOCIETY OF MEDICINE, at 9.30.—Dr. R. Hutchison: Dr. Samuel Johnson and Medicine.

#### TUESDAY, MAY 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. E. D. Adrian: The Interpretation of the Electromyogram (Oliver-Sharpey Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: Some Effects of Climate on the Circulation (III.).

ROYAL SOCIETY OF MEDICINE (Orthopaedics Section), at 5.30.—Annual General Meeting.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—F. G. Rappoport: Some Notes on Water Shut-off.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. C. F. Sonntag: Exhibition of Anthropoid Skulls presenting Features of Interest.—F. Martin Duncan: Exhibition of Cinematograph Films recently taken in the Society's Gardens.—Miss Joan B. Proctor: Notes on the Nests of some African Birds.—Miss S. S. Flower: Contributions to our knowledge of the Distribution of Life in Vertebrate Animals. III. Reptiles.

ROYAL SOCIETY OF ARTS, at 8.—Prof. J. S. S. Brame: On a New Genus of the Family Engystomatidae (Batrachia).

INSTITUTION OF CIVIL ENGINEERS, at 6.—Capt. H. Riall Sankey: Heavy-oil Engines: Some Outstanding Questions relating to Large Engines of the Self-ignition Type (James Forrest Lecture).

ROYAL PHOTOGRAPHIC SOCIETY, at 7.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.—C. H. Holbeach: (a) Some further Aspects of the Theory and Operation of Potter-Busky Diaphragms; (b) The Treatment of Coolidge Tubes.

#### WEDNESDAY, MAY 6.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—E. B. Bailey: The Tertiary Igneous Geology of the Island of Mull.

INSTITUTION OF CIVIL ENGINEERS (jointly with Institution of Mechanical Engineers, Institution of Electrical Engineers, Institution of Naval Architects, Institute of Marine Engineers, North-East Coast Institution of Engineers and Shipbuilders, Institution of Engineers and Shipbuilders, Institution of Chemistry of Great Britain and Ireland, Institution of Gas Engineers, British Electrical and Allied Manufacturers' Association, British Engineers' Association, Admiralty, War Office, Air Ministry), at 6.—J. Carnaghan: A Standard Code for Tabulating the Results of a Heavy-oil Engine Trial.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Capt. H. J. Round, T. L. Eckersley, K. Tremellen, and F. C. Lunn: Report on Measurements made on Signal Strength at Great Distances during 1922 and 1923 by an Expedition sent to Australia.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—J. King: The Adulteration of Conserves, with special reference to Pectin and Agar-agar.—J. S. Wilcox and H. T. Cranfield: The Influence of Palm Kernel Meal on the Composition of Bacon Fat.—C. H. Ridsdale and N. D. Ridsdale: Points arising from the Analytical Standardisation of British Chemical Standards.—Dr. B. S. Evans: (a) A New Method for the Separation and Determination of the Alloys; (b) A New Colorimetric Method for the Determination of Cobalt in the Presence of Nickel.—W. B. Walker: The Determination of Small Amounts of Iron by Colorimetric Methods.

ROYAL SOCIETY OF ARTS, at 8.—Air Vice-Marshal Sir William Sefton Brancker: Commercial Aviation.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Prof. H. A. Lorentz: The Motion of Electricity in Metals (Annual May Lecture).

ROYAL SOCIETY OF MEDICINE (Surgery Section) (Annual General Meeting), at 8.30.—Informal Discussion on Acute Small Intestinal Obstruction.

#### THURSDAY, MAY 7.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10.—Presidential Address.—T. W. Hand: Progress in British Rolling-mill Practice.—A. Hultgren: "Flakes" or "Hair Cracks" in Chromium Steel, with a Discussion on "Shattered Zones" and "Transverse Fissures" in Rails.—At 2.30.—T. H. Turner and J. D.

Jevons: The Detection of Strain in Mild Steels.—J. D. Jevons: Strain Detection in Mild Steel by Special Etching.—L. Aitchison and L. W. Johnson: The Effect of Grain upon the Fatigue Strength of Steels.—A. G. Lobley and C. L. Betts: The Influence of Gases at High Temperatures upon Iron, with special reference to the Formation of Blowholes.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—Dr. W. Rosenham and Miss J. McMinn: The Plastic Deformation of Iron and the Formation of Neumann Lines.—Dr. A. E. H. Tutton: (a) The Monoclinic Double Sulphates containing Thallium, Thallium Nickel and Thallium Cobalt Sulphates; (b) The Crystallographic and Optical Properties of Iodo-Succinimide.—Kathleen Yardley, An X-Ray Examination of Iodo-Succinimide.—To be read in title only.—B. Lambert and S. F. Gates: An Investigation of the Relationships existing between Hydrogen and Palladium.—C. G. T. Morison: The Effect of Light on the Settling of Suspensions.

LINNEAN SOCIETY OF LONDON, at 5.—G. C. Robson: Exhibition of the Rare Cephalopod, Spirula.—Sir Sidney F. Harmer: Exhibition of Specimens illustrating Old Age in Cetacea.—Dr. H. G. Cannon: Exhibition of Specimens showing Ectodermal Origin of Muscles in the Crustacean Cheirocephalus.—Miss Andersson: The Genetics of Ferns.—S. L. Moore: A Third Contribution to the Composite Flora of Africa.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. E. D. Adrian: The Interpretation of the Electromyogram (Oliver-Sharpey Lectures) (II.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. H. J. Fleure: Prehistoric Trade and Trade of the West Coasts of Europe (I.).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynaecology Section), at 6.—Annual General Meeting.

CHEMICAL SOCIETY, at 8.—E. H. Ingold: The Tautomerism of Dyads. Part III. The Effect of the Triple Bond on the Reactivity of Neighbouring Atoms.—J. O. Cutler, J. B. Conner and Prof. T. M. Lowry: The Rotatory Dispersive Power of Organic Compounds. Part XVI. Halogen-derivatives of Camphor.—S. Sugden, J. B. Read, and H. Wilkins: The Parachor and Chemical Constitution. Part I. Polar and Non-polar Valencies in Unsaturated Compounds.—J. P. Griffiths and C. K. Ingold: The Tautomerism of Dyads. Part IV. New Evidence of the Tautomeric Mobility of Oximes.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynaecology Section), at 8.—Annual General Meeting.

#### FRIDAY, MAY 8.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10.—R. H. Greaves and J. A. Jones: Temper-brittleness (Part I).—J. B. Conner and J. O. Cutler: Temper-brittleness in relation to Chemical Constitution.—D. B. Peeling and H. Field: "Peeling" in White Heart.

ROYAL SOCIETY OF ARTS, at 8.—G. E. Sandland: Some Notes on the Use of a Diamond Pyramid for Hardness Testing.—J. H. Whiteley: Observations on Martensite and Troostite.—B. D. Ekin: The Structure of Quenched Carbon Steels.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Gilbert T. Walker: Indian Meteorology.

ROYAL ASTRONOMICAL SOCIETY, at 5.—A. N. Kriloff: On Sir Isaac Newton's Method of Determining the Parabolic Orbit of a Comet.—J. Evershed: On Some Measures of the Solar Rotation at Different Levels of the Chromosphere.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—E. Hughes: A Magnetic Bridge for Testing Straight Specimens and an Analysis of the Hysteresis Loop of Cobalt Chrome Steel.—M. C. Johnson: The Experimental Control of Electrically Broadened Spectral Lines.—M. K. Rao: On the Spectra of the Metals of the Aluminium Sub-group.—Prof. A. O. Rankine: Demonstration of the Diffraction of Light by a Spherical Obstacle.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Fourth Report of the Steam-Nozzles Research Committee.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—A. C. Wire: Five Weeks in the High Alps.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.

ROYAL SOCIETY OF MEDICINE (Ophthalmology and Comparative Medicine Sections), at 8.30.—Discussion on Diseases of the Eyes Common to Man and Animals.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. H. H. Dale: The Circulation of Blood in the Capillary Vessels.

#### SATURDAY, MAY 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—G. L. Bickersteth: Byron and Italian Literature (I.).

#### FREE PUBLIC LECTURES.

#### TUESDAY, MAY 5.

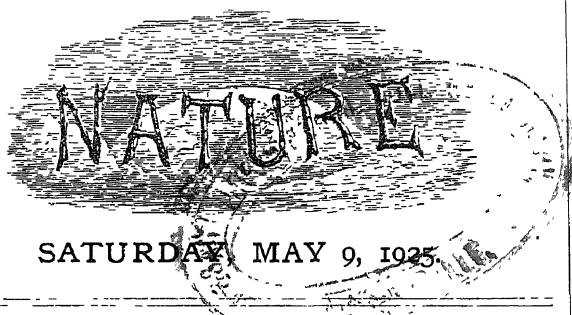
LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Prof. A. Van Gennep: Some New Methods in the Study of Primitive Man. (Succeeding Lectures on May 7, 8.)

#### THURSDAY, MAY 7.

GUY'S HOSPITAL MEDICAL SCHOOL, at 5.—Sir J. J. Thomson: The Structure of Light (Fison Memorial Lecture).

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Prof. W. E. Dixon: The Cerebro-spinal Fluid, with special reference to Pituitary Secretion.

KING'S COLLEGE, at 5.30.—Prof. A. Cabrera: Prehistoric Paintings in Spain. (Succeeding Lectures on May 14, 18, 21.)—At 6.30.—Dr. O. Vočadlo: The Czechoslovak Republic To-day: Population and Racial Problems.



SATURDAY, MAY 9, 1925

## CONTENTS.

	PAGE
Anthropology and Administration . . . . .	666
Natural Science and Religious Beliefs. By Dr. J. S. Haldane, F.R.S. . . . .	667
The Living Cell. By J. S. Huxley . . . . .	669
Human Biometrics. By M. G. . . . .	671
Our Bookshelf . . . . .	672
Letters to the Editor :	
Self-diffusion in Solid Metals.—Prof. G. Hevesy and Mrs. A. Obrutsheva . . . . .	674
Evolution, and the Age and Area Hypothesis.— A. E. Watkins . . . . .	675
The Growth of Fish.—J. Gray . . . . .	676
Formation of Waterspouts.—C. S. Durst . . . . .	676
Chromosomes in Avena.—C. L. Huskins . . . . .	677
Pinhole Photography.—B. K. Johnson . . . . .	678
The Choice of Wave-lengths for Achromatism in Telescopes.—Lieut.-Col. J. William Gifford . . . . .	678
The Teaching of Evolution in the United States.— Prof. Bert Cunningham . . . . .	678
A Curious Survival.—Sir Oliver Lodge, F.R.S. . . . .	678
The Pigmentation of Animals By Prof. Joseph Barcroft, F.R.S. . . . .	679
The Hebrew University in Jerusalem. By S. B . . . . .	681
Current Topics and Events . . . . .	682
Our Astronomical Column . . . . .	686
Research Items . . . . .	687
Echo Sounding. By J. B. . . . .	689
The Microscope in Science and Industry . . . . .	691
The "Honey-Sense" of Bees By E. J. S. . . . .	692
University and Educational Intelligence . . . . .	692
Early Science at Oxford . . . . .	693
Societies and Academies . . . . .	694
Official Publications Received . . . . .	696
Diary of Societies . . . . .	696

## SUPPLEMENT—

The Centenary of Huxley . . . . .	697
Home Memories. By Dr. Leonard Huxley . . . . .	698
Huxley. By Sir E. Ray Lankester, K.C.B., F.R.S. . . . .	702

NO. 2897, VOL. 115]

Thomas Henry Huxley. By Prof. E. B. Poulton, F.R.S. . . . .	704
Plant Biology in the 'Seventies. By Sir W. T. Thiselton-Dyer, K.C.M.G., C.I.E. . . . .	709
Teaching of Biological Science By Prof. F. O. Bower, F.R.S. . . . .	712
The Beginnings of Instruction in General Biology By Prof. S. H. Vines, F.R.S. . . . .	714
Huxley and Evolution By W. Bateson, F.R.S. . . . .	715
Huxley as Evolutionist. By Prof. J. Arthur Thomson . . . . .	717
Huxley as Anthropologist. By Sir Arthur Keith, F.R.S. . . . .	719
Evolution and Man By Edward Clodd . . . . .	724
Enduring Recollections. By Dr. Henry Fairfield Osborn . . . . .	726
Contributions to Vertebrate Palæontology. By Sir Arthur Smith Woodward, F.R.S. . . . .	728
Structure and Evolution in Vertebrate Palæonto- logy By Prof. D. M. S. Watson, F.R.S. . . . .	730
Geological Thought and Teaching. By Prof. W. W. Watts, F.R.S. . . . .	732
Huxley's Contributions to our Knowledge of the Invertebrata. By Prof. E. W. MacBride, F.R.S. . . . .	734
Processes of Life and Mind. By Prof. C. Lloyd Morgan, F.R.S. . . . .	737
Huxley as Teacher. By Prof. Patrick Geddes . . . . .	740
Huxley's Message in Education. By Prof. H. E. Armstrong, F.R.S. . . . .	743
The Master. By Prof. W. J. Sollas, F.R.S. . . . .	747
Truth and Righteousness. By Stephen Paget . . . . .	748
Huxley's Message to the Modern World. By Prof. T. D. A. Cockerell . . . . .	750
Personal Impressions. By C. V. Boys, F.R.S. . . . .	751
A Student's Reminiscences. By Rev. E. F. Russell . . . . .	751
The Huxley Memorial Lecture and Medal of the Royal Anthropological Institute. . . . .	752

## Editorial and Publishing Offices:

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### Anthropology and Administration.

IN the hundred years that have elapsed since the birth of Huxley, anthropology has made greater strides than perhaps any other branch of science with which he was concerned. The measure of his contribution to that advance cannot be gauged only by the results of his purely anthropological work. It is to be judged as much by the spirit and the outlook with which he approached the scientific problems of his day. It is scarcely an exaggeration to say that in Huxley's earlier years the study of primitive peoples was little more than a collection of facts, while any attempt at generalisation was usually subservient to some preconceived theory. The application of the Darwinian hypothesis to the study of man as a social and moral being, as well as a physical entity, by Huxley and his fellow-workers, diverted that study from the static to the dynamic point of view. This change of outlook, which involved the fundamental conception of the essential unity of the human race and of human culture, laid the foundation of anthropological studies as a science in aim and in method. Looking back on the work of the latter half of the last century, it is easy to criticise the facile generalisations which arose from an unwarranted extension of a purely biological hypothesis; but it opened the way to the conception of continuity in development and the phylogenetic study of anthropological data—a fruitful source of advancement in the study of man and his works.

Huxley's aim as a scientific man was to promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life. The practical application of the results of anthropological study, perhaps in a sense more immediate than Huxley intended, has been forced upon the attention of the anthropologist by the march of events to which the growth of the British Empire has been due, and the inclusion under our rule of many millions belonging to the races which, in the main, are the raw material of his investigation. With the Indian Mutiny began a process of change in our attitude towards primitive races which was still going on at the time of Huxley's death, when we were only just setting foot beyond the fringe of tropical Africa, and is not yet perhaps complete. The indifference of the early days of colonisation which led to an appalling mortality among subject primitive populations and in some cases to their extinction, has given way to a conception of responsibility, not merely for their control and government, but also for their development along lines leading to a higher plane of culture.

The history of our relations with primitive races can be written in a few words—indifference, sometimes tempered by hostility, exploitation, protection, and now at last an increasing disposition to accept a system of tutelage. In all the early stages an exception must

be made in the case of the great work of the missionaries who, whatever their errors of judgment, toiled wholeheartedly and with single purpose for what in their eyes seemed the good of their charges; in recent years they have proved the valued allies of administrators.

Problems of administration have become increasingly grave and difficult of solution since the War. Leaving aside India and Egypt, from all parts come accounts of unrest, or of an awakening which may lead to unrest, among native populations. The return of troops from active service, the propaganda of political agitators among the more advanced, and the increased prosperity of the individual, as in Uganda since the cotton boom, have contributed to this in varying degree. In Africa in particular these problems have become acute. All credit must be given to both missionaries and administrators who have endeavoured to cope with the evils, political, social, and moral, arising from the process of rapid detribalisation which is going on in certain parts of Africa. They look to education to substitute a controlling influence in place of the old tribal regime.

It is clear, however, that to be effective in securing this end, any system of education must tend to raise the level of the population as a whole, and not merely afford opportunity to individuals of exceptional capacity. Both the Phelps-Stokes Educational Commission and the Advisory Committee on Education in Tropical Africa have recognised the principle that education should be vitally related to the life of the tribe, its religion, its agriculture, its industries, its hygiene, and its recreations. The latter body, in a recently published memorandum, "Education Policy in British Tropical Africa" (Cmd. 2374), points out that

"the central difficulty in the problem lies in finding ways to improve what is sound in indigenous tradition. . . . Since contact with civilisation—and even education itself—must necessarily tend to weaken tribal authority and the sanctions of existing beliefs, and in view of the all-prevailing belief in the supernatural which affects the whole life of the African, it is essential that what is defective should be replaced."

In defining the general character and aim of the type of education the Committee has in view, it is stated that its object *inter alia* should be "the training of the people in the management of their own affairs and the inculcation of true ideals of citizenship and service." The intention of this memorandum is admirable and the aim it states is beyond reproach. It is, however, permissible to doubt whether an anthropologist might not have put the case rather differently. While granting that "citizenship and service" may be the avowed aim of education in a western community, and quite possibly the only aim for whatever people an educational system may be devised, it is somewhat remote from a mentality such as that of an African native, to whom it is quite logical to demand a fee from a Medical Officer by whom he

has been treated or compensation for the time his children may spend in being educated in a school—a mentality which by tradition of generations immemorial knows no constraint beyond the *force majeure* of a primitive belief, a primitive tribal custom, and the power of his chief.

While watching with interest the experiments at Achimota in the Gold Coast Colony, and at Fort Hare in South Africa, for developing a purely African training for the Africans by themselves, the anthropologist realises the burden to be laid upon the administration, to whom will fall the task of working out the details of a scheme of education on the lines suggested. Experience has shown in Africa and elsewhere the danger of eliminating any detail in a primitive social system which may to the European appear detrimental or otiose. The psychological effect of the suppression of head-hunting in New Guinea has frequently been quoted. The mistaken ban on the *lobola* (bride price) in South Africa led to social disaster. In Central Africa the loss of their cattle in certain tribes through the ravages of the tsetse fly has compelled them to take to agriculture, but has produced matrimonial chaos through the destruction of the medium for acquiring a partner in marriage. Examples could be adduced almost without number to illustrate the difficulties and dangers besetting any change made without the most intimate knowledge of the ramifications of tribal custom and belief.

Anthropologists for long have urged that officials who are engaged in administering the affairs of peoples of non-European culture should receive a training in anthropology and its methods. They have pointed out that such training, by enabling them to get more quickly into touch with the mentality of the people over whom they have jurisdiction, would eliminate the mistakes which are inevitable until they have acquired by long experience a sympathetic understanding of their customs and ways of thought. The importance of this as a factor in administration has been enhanced by the difficulties which have arisen since the War, but it will be increased many fold should it fall to the official to be responsible for the modification of tribal custom in such a way that tribal authority may not break down before some adequate substitute can be found.

It may not be out of place to refer to the recent correspondence in the *Times* in which a number of prominent anthropologists expressed in the strongest terms their sense of the importance of the study of primitive races and of the training of officials in such studies in the interests of imperial administration. It was further pointed out that a central organisation was needed at which data relating to these peoples might be collected and collated for study and official use. In indicating the Royal Anthropological Institute as the body most fitted for this purpose, it is interesting to note that they named an organisation of which Huxley was virtually the founder.

### Natural Science and Religious Beliefs.

- (1) *What I Believe*. By Bertrand Russell. (To-day and To-morrow Series.) Pp. 95. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1925.) 2s. 6d. net.
- (2) *The Religion of a Darwinist: Conway Memorial Lecture delivered at South Place Institute on March 26, 1925*. By Sir Arthur Keith. Pp. 76. (London: Watts and Co., 1925.) 2s. net.
- (3) *Science and Religion*. By Prof. J. Arthur Thomson. Pp. ix+238. (London: Methuen and Co., Ltd., 1925.) 7s. 6d. net.

THE fame of most scientific men depends on their positive contributions to some particular branch of science; but Huxley's fame depends mainly on the clarity and fearlessness with which he not only expressed scientific conclusions, but also extended their application to the beliefs popularly held in his time, and particularly to theological beliefs. The smoke of controversy rolled round his writings forty or fifty years ago, and, though some of it has cleared away, it still continues to roll round the subjects on which he wrote. The three short books referred to above are sufficient evidence of this.

In his "What I Believe" Mr. Bertrand Russell expresses the view that reality as described in the terms of existing physics corresponds to ultimate reality:

"Given," he says, "the laws governing the motions of electrons and protons, the rest is merely geography—a collection of particular facts telling their distribution throughout some portion of the world's history. The total number of facts of geography required to determine the world's history is probably finite: theoretically they could all be written down in a big book to be kept at Somerset House, with a calculating machine attached, which, by turning a handle, would enable the enquirer to find out the facts at other times than those recorded." . . . "Of this physical world, uninteresting in itself, Man is a part. His body, like other matter, is composed of electrons and protons, which, so far as we know, obey the same laws as those not forming part of animals and plants." . . . "God and immortality, the central dogmas of the Christian religion, find no support in science." . . . "Fear is the basis of religious dogma, as of so much else in human life. Fear of human beings, individually or collectively, dominates much of our social life, but it is fear of nature that gives rise to religion." . . . "The philosophy of nature must not be unduly terrestrial: for it the earth is merely one of the smaller planets of one of the smaller stars of the Milky Way. It would be ridiculous to warp the philosophy of nature in order to bring out results that are pleasing to the tiny parasites of this insignificant planet. Vitalism as a philosophy, and evolutionism, show in this respect a lack of sense of proportion and logical relevance. They

regard the facts of life, which are personally interesting to us, as having a cosmic significance, not a significance confined to the earth's surface." . . . "All such philosophies spring from self-importance, and are best corrected by a little astronomy."

These quotations will give a good idea of the main argument running through the book, which is simply and brilliantly written, and will well repay reading by those who are really trying to understand ideas which, consciously or subconsciously, appeal to many men of science and to a far larger number of persons whose beliefs are influenced by scientific conclusions. The close kinship between Mr. Russell's ideas and those put forward by Huxley, and also by Laplace at the end of the eighteenth century, will be evident.

Sir Arthur Keith's "The Religion of a Darwinist" is written with all the charm and appeal to human interest which we are accustomed to find in his popular writings on anthropological subjects. He bases his religion on the fact of biological progress, though he traces that progress to nothing but the "machinery at work in all living things," and he regards that machinery as still omnipotent.

"One can conceive that into one of these primitive tribes, such as hunted over the site where we now meet, there may have been born at occasional times a dreamer who longed for the day when all that was good in the intratribal spirit would leap the frontier which encircled him and his fellows, and spread goodwill and fellowship through all surrounding tribal territories. This was the ideal which issued from Nazareth over nineteen centuries ago. Christ's mission in life was to break down tribal boundaries—the fences which Nature had set up with such infinite ingenuity and patience. He sought to make mankind one tribe, and the intratribal practice of mercy the common law of the world. The soldier and the diplomat worked for the same end by substituting force for the sweet persuasion of the Evangelist. How far they have succeeded, and how far they have failed are shown on the present map of the world, and by the present state of international politics. . . . They cannot succeed until they have smashed the machinery of evolution—the machinery which has made the world what it now is."

Sir Arthur Keith's conclusion here seems to be different from that expressed by Huxley in his famous lecture on evolution and ethics. Huxley was with the idealists, and boldly exhorted us to smash the "machinery" of evolution. If in this he was not logical, and seemed to be calling in something which on his own philosophy could not exist, is not Sir Arthur Keith less than logical too? Would not Mr. Russell's prescription of "a little astronomy" remove the basis of his religion? Is the evolution of life on this small planet anything but a transient ripple on an ocean of mechanical happenings?

Prof. J. Arthur Thomson's book "Science and Re-

ligion" is written from a very different point of view, and starts from the actual existence of religious belief implying "a recognition of a higher order of reality than that reached in ordinary experience." "Its essence is threefold—submission to the Divine Will, some form of communion with the Divine, and a vision of God." The book is a discussion of the apparent conflict between natural science and religion, and maintains that there are no real grounds for conflict, provided that both religious beliefs and scientific beliefs confine themselves to their proper spheres. But there lies the rub: for both natural science and religion lay claim to be representative of the whole of our experience, and though Prof. Thomson has no hesitation in throwing overboard traditional theology wherever it is inconsistent in mere points of detail with natural science, the fundamental clash seems to remain.

Much of the book is devoted to pointing out that the interpretations of any particular branch of natural science are only partial interpretations of what is actually perceived. Physical science, for example, takes no account of such things as beauty, and gives no satisfactory account of life. In face of conscious experience it has nothing to say which throws any light on the connexion of consciousness with physical change.

"There is much to be said in favour of the admittedly difficult view that living organisms emerged from the dust of the earth. If so, and if the world's process is continuous, then there must be in the dust the promise and potency of life. And where life is, mind may be. If the dust of the earth came from the primitive nebula, then in the nebula also must have been more than met the eye. . . . We adhere to the Aristotelian idea that there can be nothing in the end which was not also in kind in the beginning. . . . But it is not to this immanent panpsychism that we mean to refer when we speak religiously of the Unseen Universe. The religious refers to a Spiritual order, which can only be religiously discerned. It is the idea of a Creation which was not an event over and done with unthinkable millions of years ago, but remains as an enduring Divine thought."

It is probable that most men of science will be prepared to admit that they do not know what may lie behind the present physical interpretation of the universe. But between the world as physically interpreted and the world of conscious experience a gulf is left, so that statements such as those quoted in the last two sentences from Prof. Thomson seem incapable of being brought into any relation with physical interpretation.

During the nineteenth century natural science became almost entirely divorced from philosophy. It is becoming more and more evident that this un-

fortunate position cannot continue if either natural science or philosophy is to throw all the light it is capable of throwing on such questions as are discussed in the three books before us.

For those who take philosophy seriously it is no longer possible to regard the world, except for mere convenience in dealing with limited practical problems, as consisting of "bodies," whether conscious or unconscious, existing independently of one another in space, and subject to a series of independent events in time. The reasoning of Hume and Kant cannot be neglected, and made the interpretations of Galileo and Newton no longer possible as ultimate interpretations. Our universe must in some way be one existence, and not a collection of separate existences, whether these separate existences be regarded as physical bodies or units of sensation.

Space and time themselves do not lie outside the scope of the reasoning of Hume and Kant; and from this point of view the detailed reasoning of the three books under review appears scarcely adequate to their subject. When Laplace swept the heavens with his telescope, or when Darwin swept the remote past of man and other living organisms, neither of these great men of science was escaping from the One Existence manifested in his own perceptions and endeavours. Kant and his immediate successors at least pointed the way towards a deeper rational account of our experience—an account in which æsthetical, ethical, and religious experience have cosmic significance which stands out behind the partial interpretations of natural science.

At the present time it would be as futile to raise a cry of "back to Kant" as it would be, in physics, to raise one of "back to Galileo and Newton." We may safely say that had Kant foreseen the progress of physics and biology since his time, the details of his philosophical writings would have been very different, and his main reasoning would have stood out far more compact and intelligible, freed from the artificial discontinuity which exists between his accounts of physical interpretation and of æsthetical, ethical, and religious interpretation.

It was through his failure to take adequate account of philosophical progress that Huxley fell short on the philosophical side. He never carried with him the philosophers in his wider conclusions. Nevertheless, he took a leading part in clearing away a vast accumulation of harmful theological debris, and he was a fearless fighter for what he believed to be right and true. Those who are firm in the conclusion that the universe is one spiritual universe have good reason to honour his memory.

J. S. HALDANE.

## The Living Cell.

*The Cell in Development and Heredity.* By Prof. Edmund B. Wilson. Third edition, revised and enlarged. Pp. xxxvii + 1232. (New York: The Macmillan Co., 1925.) 36s. net.

PROF. E. B. WILSON is the leading figure among the older American biologists—a rare combination of the scholarly mind with the adventurous research spirit. All who know him, whether personally or through his work, will be glad that, in spite of the protracted ill-health from which, alas, he has been suffering for some years, he has been able to crown his scientific career by the issue of this book.

I say book advisedly; for while this purports to be but a third edition of an old work, the second edition was published in 1900, and the lapse of a quarter-century has necessitated not merely radical revision but in most chapters a rewriting of the whole. In its new guise it is a formidable volume—more than twice the length of the second edition—of 1200 pages, and more than 500 illustrations—a fitting companion to that other great American work on the same subject which has recently appeared, the "General Cytology" edited by Cowdry. This latter is a composite work, by many authors; what it gained in many-sidedness it lost in unity; whereas unity of treatment is one of the outstanding features of Wilson's book, which is in no sense a mere compilation, but a work of most deliberate plan and careful execution.

Wilson's own cytological work began in the middle 'eighties: and it is a welcome reminder of the extraordinary rapidity of the rise of this branch of biology to realise that the book is to all intents and purposes a summary of progress achieved in the subsequent forty years. What had gone before had consisted essentially in the discovery first of cells and then of chromosomes, and in the proof of their general and almost universal existence; on these bases is reared the vast edifice of detail here presented to us.

The book opens with a wholly admirable historical introduction, followed by a chapter on general cell-morphology. Then come special chapters on special aspects of the cell—mitosis, reproduction in general, the gametes, fertilisation, meiosis. There follow three general chapters on reproduction and sex in low organisms, on some aspects of cell-chemistry and physiology, and on some problems of cell-organisation. Finally we reach that aspect of the subject which perhaps more than the rest Prof. Wilson has made his own—the relations between cytology and, on one hand, heredity, on the other, early development. A chapter on chromosomes and sex is followed by others on chromosome morphology; chromosomes and heredity; growth, cell-

division and development; and finally, development and heredity. Perhaps "finally" is not the right word, since there is still to come a hundred pages of glossary, index, and (chiefly) list of literature.

On May 4, 1825, Thomas Huxley was born. Wilson's historical retrospect will serve as a forcible reminder of the wonderful progress of our knowledge in the century that has since then elapsed. Prévost and Dumas, in the year before he was born, had given the first accurate description of cleavage and the definitive proof that the spermatozoa were the active agents of fertilisation. The cell-theory was promulgated when he was a boy in his 'teens, and by 1855 had assumed the definitive form epitomized in Virchow's aphorism "*omnis cellula e cellula*." Descriptive histology and embryology had meanwhile been rapidly accumulating facts, and had paved the way for cytology proper. Huxley was fifty when Oscar Hertwig proved that the sperm and the ovum each contributed one of the two nuclei that fused at fertilisation; and before he was sixty the essential facts of mitosis had been discovered, and biologists had begun to concern themselves with the phenomena of meiosis. Through the brilliant critical speculations of Weismann, attention was focussed on the point, and before Huxley died, he had obtained a comprehensive view of this amazing microscopic machinery of the chromosomes and of its significance for life in general—a view which we know from his writings afforded the keenest intellectual pleasure to his old age. In the short thirty years since his death, there has come the rediscovery and amplification of Mendel's work, the transformation of the chromosome hypothesis from an interesting speculation into one of the foundations of biology, and the penetration beyond the visible chromosomes to their invisible component units—a penetration comparable to that effected in physico-chemical science by the atomic theory.

It is impossible to criticize a book of the scope and calibre of Wilson's from the point of view of trivial errors of fact or of what the reviewer may consider errors of judgment on isolated points; but a few words may be said about its general treatment and its broad bearings. The sections into which it falls are of rather unequal value. In the first place, there is an almost complete absence of any treatment of histogenesis (save that of the gametes) from the cytological point of view. This perhaps does not fall within the scope of the book: but it is a pressing task for some one to undertake. The chapter on cell-chemistry and cell-physiology, as the author himself makes plain, is scarcely meant as more than a reminder that these aspects of the subject exist. The rest of the book really resolves itself into, first, a general section on the cell and cell-organisation; secondly (and largest), into a

treatise on chromosomes, their behaviour, and their relation to heredity and sex; and thirdly, an introduction to experimental embryology from a rather peculiar angle.

The first is a straightforward and excellent account. In the present state of our ignorance on such subjects as the function of Golgi bodies and the mechanism of mitosis, it is impossible for it, building a foundation of established principle, to be more than this.

The third constitutes the most important general work on the experimental analysis of the early stages of development which has appeared since Jenkinson's book in 1909. It will be read with the greatest interest by all who are occupied with experimental biology; and yet, in spite of its treasure of well-arranged facts and its lucid discussion, it cannot be said to provide a wholly satisfactory treatment. In the first place, it is really impossible to separate the early from the later stages of development. The attempt had to be made by Prof. Wilson if he were not to trespass outside the limits of cytology; but it has only revealed that the problems here attacked are essentially *not* cytological, but can be treated only as part of a comprehensive science of developmental physiology.

In the second place, the author is writing at a time of great discoveries in the subject—discoveries of a sort which make one's treatment out-of-date between proof-correction and publication. For example, if Prof. Wilson had been able to take account of Spemann's recent remarkable work on embryonic grafting, he could not have continued to lump together the type of pre-determination in the amphibian egg before the close of segmentation with that found during and after gastrulation.

During the first period, as we now know, there is a predetermination of axes and gradients only, and the germ (apart from the batteries of specific potencies latent in its chromosomes) contains only raw materials, non-specific from the point of view of future organs: during the second all is changed, and the germ becomes a chemical mosaic of irreversibly-determined regions, under the influence, at present unexplained, of the dorsal lip of the blastopore. True "organ-forming stuffs" are thus present only in the second period: in the first (as Jenkinson's rather neglected centrifuging experiments showed) there exist only crude materials.

Wilson's own researches in the subject had largely been devoted to forms, such as *Dentalium*, in which true organ-forming materials appear very early. I venture to prophesy that these will all turn out to be cases of *precocious* formation of specific stuffs, brought about as an adaptation to very rapid development into a specialised larva, so that the two stages which are readily distinguishable in the slower-developing Amphibia are here superposed and entangled.

Finally, Prof. Wilson allows himself to follow too readily the morphologist's inclination to pin his faith to "stuffs" and regions, and has consequently been led to under-rate the importance of the graded change in physiological activity emphasised by Child and others.

With the remaining section, however, the case is different. The chapters on the chromosomes will long remain our acknowledged *locus classicus* on the subject. There will naturally be great accessions to our knowledge of the physiology of chromosomes; but as regards their appearance, behaviour, and general significance, it is safe to say that the essential principles have already been discovered; and these are fully and admirably summarised in the book before us. Chromosomes exist in all but the lowest organisms; they are often differentiated one from the other, and each is in its turn composed of differentiated units arranged in a linear series: they preserve, if not their individuality, at least their "genetic continuity" (an excellent phrase introduced by Wilson); they are divided equationally in ordinary mitosis, but whole paternal and maternal chromosomes separate from each other at reduction; and they are concerned with the determination of the enormous majority of inherited characters.

Wilson disposes readily enough of Loeb's contention that the egg-cytoplasm, quite apart from chromosomal influence, constitutes the "embryo in the rough," and shows vividly how apparent exceptions to the chromosome theory of heredity have been proved not only to be compatible with it, but also have often become converted into some of its most important supports.

After reading this book with Morgan's "Physical Basis of Heredity" as companion volume, there should be no excuse for those sceptics who wish to deny the chromosomes any importance in heredity whatsoever, or those others who would allow us to believe that the chromosomes are concerned in inheritance, but shrink from the further step—the association of particular chromosomes with sex-determination and the analysis of individual chromosomes into specific genes—which the accurate quantitative work of the last fifteen years has led most of us to take.

The evidence is here marshalled in detail, analysed, discussed. From it issues unescapably the conclusion that the physical basis of heredity (with a few exceptions, such as those of plant plastids) consists of the chromosomes or something contained in them, and that this "something" consists of an orderly series of particulate chemical units, orderly both as regards quantitative proportions and spatial arrangement.

With this, one chapter in biology is closed and another begins. We cannot do better than recommend this book to all who are interested in the chapter which is closing or that which is opening before us. J. S. HUXLEY.

### Human Biometrics.

*Studies in Human Biology.* By Prof. Raymond Pearl. Pp. 653. (Baltimore: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1924.) 8 dollars.

THE unhesitating, unrelenting diligence of the great investigator who has been to Francis Galton all, and more than all, that Huxley was to Charles Darwin, makes us forget that "Biometry" is no longer a new subject. Prof. Raymond Pearl was not one of Prof. Karl Pearson's earliest disciples; pupils of an earlier generation, such as the president of the Royal Statistical Society, are happily still in their time of fullest vigour, and it will be many years before Prof. Pearl can describe himself as a veteran. Nevertheless, he is able to put forth a volume containing the fruits of twenty years' work with the tools forged by Karl Pearson in fields first surveyed by Francis Galton. The publisher's advertisement alleges, with more truth than usually found in such documents, that the book will interest twelve not entirely distinct categories of educated men, including biologists, medical men, economists, and mathematicians; the author, with equal truth, says that "a book of this sort can make only such claim for unity as inheres in the *point of view* of its author."

It would indeed be difficult to think of subject-matters more disparate than the mass of the brain studied in the first hundred pages and the law of population growth considered in the last hundred. This, however, is common to both, the faith expressed in Kelvin's words: "When you can measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind."

The subject-matter is arranged under four headings: Part I., "Considering Man as an Animal," contains four papers, the longest that on brain-weights, biometric in the narrower sense of the word as used twenty years ago. Part II., "Biological Aspects of Vital Statistics," although including two chapters, one on mortality and evolution and another on the influence of physical activity upon mortality, of a somewhat speculative character, is again a straightforward application of statistical methods to subjects universally admitted to be within the modern statistician's province. The chapter on the vitality of the peoples of the United States is, in the reviewer's opinion, an especially valuable contribution to knowledge. Part III., "Public Health and Epidemiology," apart from an excellent piece of descriptive statistics on national food consumption, breaks fresh ground, particularly the study of some biological factors in the epidemiology of influenza. Part IV. is devoted to the "Population Problem," and,

as the methods adopted were the principal topic of Mr. Udny Yule's recent presidential address to the Royal Statistical Society, it is scarcely necessary to say that Prof. Pearl's treatment of the problem is interesting and valuable.

Although the arrangement of the book is not strictly chronological, the memoir on brain-weight and the studies of influenza are nearly twenty years apart.

There will certainly be some to shake their heads and regret that Prof. Pearl did not continue in the admirable course of his earlier youth. The memoir on brain-weights is a finished piece of work; the author is familiar with the relevant literature, he has shown good judgment in his choice of data, and has reduced those data in the best way; the problem he essayed to solve he has solved. The studies of influenza, on the other hand, are incomplete; statistical indices of dubious import are employed, alternative explanations of particular results are not fully considered, and all the relevant data are not examined. The author has wandered from the path of biometric rectitude. Such might be the judgment of a "safe" man. But there will never be any shortage of "safe" men, whether in subsidised laboratories or suburban railway carriages. There will always be plenty of people terrorised by specialists and afraid to venture into a field without the landlord's written permission. It is well that Prof. Pearl has courage, and will not be deterred by the criticisms of any of the twelve groups invoked by his publishers from still more flagrant trespasses than are recorded in the present volume. In twenty years' time, in his next volume of collected writings, he will no doubt modify some opinions he now holds. Only very stupid people are always right. M. G.

### Our Bookshelf.

*Untersuchungen über Triphenylmethanfarbstoffe Hydrazine und Indole.* Von Emil Fischer. Herausgegeben von M. Bergmann. (Emil Fischer: Gesammelte Werke.) Pp. ix+880. (Berlin: Julius Springer, 1924.) 9.30 dollars.

THE volumes of Emil Fischer's papers, already reprinted in this series, cover the great groups of natural substances with the investigation of which his name is specially connected—carbohydrates and ferments; amino-acids, polypeptides and proteins, depsides and tannins, and purines. The reprinting of the papers was begun by Fischer himself in 1906, and since his death it has been continued by his friend and collaborator, Dr. M. Bergmann.

The volume now under notice is the penultimate of the series, but chronologically it comes first as it contains Fischer's earliest work, beginning with his inaugural dissertation on fluorescein and phthalein-orcin, presented at Erlangen in 1874. Though this deals with synthetic substances it already reveals Fischer's bent of mind towards research on natural products, since it

starts by pointing out that, from the beginning of organic chemistry, the minds of chemists have hankered after the investigation of the colouring matters of plants and animals, partly because their industrial applications made them accessible, but more because a knowledge of their chemistry might throw much light on their origin and their relation to the organisms producing them. This thesis was the first of seventeen papers on triphenylmethane dyes, which Fischer published between 1874 and 1904, chiefly with Otto Fischer as collaborator. It was characteristic of him that he was able to keep more than one series of difficult researches going at one time, and while the triphenylmethane work was in progress he began the investigation of aromatic hydrazines in 1875, a research which led to the preparation of phenylhydrazine and thus provided him with the tool which he used to such advantage later on in the investigation of the soluble carbohydrates.

The work on hydrazines led in another direction to the synthesis of indoles, a reaction that is still being discussed and is still bearing fruit and, in view of the increasing realisation of the importance of the indole nucleus in complex biological products, may in the long run prove to be as important as any that even Fischer discovered. Chemists everywhere will be grateful for the care with which these volumes have been prepared by the editor and issued by the publishers. T. A. H.

*The Protection of Birds: an Indictment.* By Lewis R. W. Loyd. Pp. vii+88. (London: Longmans, Green and Co., 1924) 3s. 6d. net.

MR. LOYD'S main indictment of the present system of bird protection is its indiscriminate nature, whereby it is sought to protect all sorts and conditions of birds against the hand of man, without due regard to the effect on bird life as a whole. He points out forcibly and with a great measure of truth that indiscriminate protection may, and often does, lead to the overabundance of hardy, virile species at the expense of less adaptable kinds. As an example of this, he suggests that one result of the wholesale protection afforded to the birds of Lundy will be the gradual extermination of kittiwakes, guillemots, razorbills, and puffins by the herring gulls, which feed on their eggs and young. In the same way, he affirms that peregrines and jackdaws have accounted for the chough in its former haunts, the great skua for the whimbrel on the Orkneys and Shetlands, and gulls for the tern colonies on the Farne Islands. The author further argues that natural causes, such as floods and shortage of food, and necessary artificial causes, such as lighthouses, are responsible for more wholesale loss among birds than anything that man can accomplish, and suggests that overprotection among vigorous species may, by bringing about overcrowding and consequent epidemic, cause that very destruction which it is designed to avoid.

Mr. Loyd would apparently withdraw protection from such birds as herring gulls, starlings, sparrows, rooks, jackdaws, and little owls, in order that the other birds on which they prey in one way or another may be given a chance to survive. His denunciation of the introduction of the little owl will commend itself to others besides ornithologists. Mr. Loyd takes the opportunity to defend the collector against the calumnies levelled against him by such writers as Hudson and by the Royal Society for the Protection of Birds, and

seeks to show that collectors, far from being responsible for the extermination of species, may be regarded as bird protectionists. Collectors, however, like bird protection, are of two kinds, discriminate and indiscriminate. The latter type unfortunately exists, and no defence which Mr. Loyd brings forward can absolve him from the charges laid against him. It is against this type that the energies of writers and bird protection societies are directed.

*Chemical Synthesis: Studies in the Investigation of Natural Organic Products.* By Dr. Harry Hepworth. (Manuals of Pure and Applied Chemistry.) Pp. xx+243. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1924.) 20s. net.

NOR so very long ago authors of text-books on organic chemistry were in the habit of relegating their remarks on alkaloids, glucosides, tannins, and other natural products to the last few pages of their works, and these were not taken very seriously by either teachers or students. In the last twenty years or so all that has been changed, and there are now monographs in most languages on the more important of these products, and the larger text-books also devote some attention to them. Though information on such subjects is therefore more accessible than it was, Dr. Hepworth has rendered a conspicuous service to chemists by bringing together a summary of what is now known about natural pigments, carbohydrates, tannins, oils and fats, terpenes, polypeptides, simple natural bases and alkaloids. By restricting his attention to the analytical and synthetical reactions, which have been most useful in elucidating the structure of the more important members of each group, he has been able to produce a readable account of the present position of the chemistry of these substances and an indication of the lines on which progress is still being made. There are slips here and there; for example, it is no longer correct to say that carene does not occur in Nature, and that sylvestrene is present in Indian turpentine oil. Atropine, hyoscyamine, pseudohyoscyamine, and hyoscyne are not all isomers of the formula  $C_{17}H_{33}NO_3$ , and the formula  $C_{17}H_{21}NO_2$  does not represent scopolamine; but on the whole the book is remarkably accurate and up-to-date. It is also well produced, and graphic formulæ are supplied wherever they are useful. T. A. H.

*Histoire des sciences exactes et naturelles dans l'antiquité gréco-romaine: exposé sommaire des écoles et des principes.* Par Prof. Arnold Reymond. Pp. viii+238. (Paris: Albert Blanchard, 1924.) 12 francs.

PROF. ARNOLD REYMOND has for many years given a course of lectures on the history of science at the University of Neuchâtel. This course is attended by students in the Faculty of Letters as well as by those in the Faculty of Science, a practice which is worthy of the notice of university authorities in Great Britain and elsewhere. The present book represents that part of the course which deals with the development of mathematics, the natural sciences, and medicine in Greco-Roman antiquity. It is very well written, and shows that its author has not only a complete command of his subject, but also a ready appreciation of the requirements and mental equipment of his audiences. Whilst avoiding a parade of learning, Prof. Reymond gives full references to his authorities for any statement of

importance, and the book will thus appeal to all students of the history of science, especially those whose main interests do not lie in this particular field.

It is of course very difficult to deal adequately with such a large subject in the space of 230 pages, and detail has had to be cut down to a minimum. Nevertheless, Prof. Reymond has contrived to be readable, and as a bird's-eye view of the scientific knowledge of the ancient world his book may be heartily recommended. The increasing interest in the history of science which is manifesting itself in Great Britain suggests that an English translation might be well worth publishing. No other book of the size treats the subject with the same skill. E. J. H.

*Patents: Invention and Method.* By Harold E. Potts. Pp. viii+160. (London: The Open Court Co., 1924.) 3s. 6d. net.

IN this little book the author has collected a number of papers that he has published dealing with certain philosophical aspects of patent law and practice. Each of the six papers is presented as an application of scientific method and reasoning to the solution of patent problems, or as an attempt at the correlation of patent law with other more systematised branches of learning. This being so, it is not easy to understand why the paper on language and style should have been included, or, for that matter, that discussing the logical problem of definition. Of the first paper, too, the most that can be said is that it affords an ingenious exercise in the use of mathematical symbols. It is when he comes to discuss prediction and invention in chemistry and the influence of patent law on the evolution of research that the author is most interesting and instructive, though his remarks in the latter connexion on the subject of generalisation must be regarded rather as the personal opinion of a well-known patent agent than as an exposition of the accepted practice in this matter. The remaining paper dealing with the principles of scientific method can be commended to inventor and practitioner alike. E. J.

*Rivers and Lakes: the Story of their Development.* By Martin A. C. Hinton. (Nature Lover's Series.) Pp. x+182. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1924.) 6s. net.

THE greater part of this book treats of the work of rivers, while a few chapters are added on the origin of lake basins. Much condensation was clearly necessary to compress so vast a subject into less than two hundred small pages, but Mr. Hinton has done his work well and produced a book that is not only readable but, in spite of being strictly popular, is also accurate and full. It was obviously impossible to discuss fully the topic of ice erosion and ice protection, but the main aspects of the problem are indicated, though it would have been well to refer the reader to some of the recent papers on the glaciology of the Antarctic, where ice action on a large scale is discussed. To describe a glacier as "simply a frozen mountain stream," is not very happy, even if the following paragraphs amplify and extend the statement. The volume fully maintains the high standard of the series to which it belongs, but seventeen diagrams is a small allowance for a popular book of this scope.

### Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

#### Self-diffusion in Solid Metals.

THE "sagacity" with which atoms, or groups of atoms, oscillating about fixed points in the crystal lattice, refuse to exchange position with neighbouring atoms, is often regarded as one of the chief characteristics of the crystalline state. On the other hand, numerous cases are recorded in which crystalline bodies, for example, solid metals, penetrate into each other, in which, therefore, a replacement of the atoms of one metal by those of the other takes place. The classical experiments of Roberts-Austen on the diffusion of gold in lead bars are widely known. At a temperature as low as  $100^\circ$  he found the diffusion coefficient of gold in lead to be  $2 \times 10^{-5}$  cm.<sup>2</sup> day<sup>-1</sup>, being thus only about 100,000 times smaller than that of sodium chloride in water. Several cases of interpenetration of solid metals have been recorded since, including the interesting case of the diffusion of thorium in heated tungsten wires, reported recently by Langmuir. But it must be noticed that from the rate at which one metal like gold diffuses in another like lead, no conclusion can be drawn about the velocity with which the atoms change their position either in a bar of pure lead or of pure gold; no conclusion can be drawn on the rate of self-diffusion in these elements.

The idea of self-diffusion was introduced by Maxwell, when calculating the rate of diffusion of gases. The calculation was very much simplified by considering the case in which the molecules of the two diffusing gases had the same properties, for example, the exchange of place of molecules in a column of nitrogen. The use of the radioactive isotopes of lead enabled one of the writers, in collaboration with J. Groh (*Ann. d. Phys.*, 65, 216, 1921), to realise a measurement of self-diffusion in the case of liquid and solid lead, the diffusion in liquids and solids being practically independent of the difference in the masses of the isotopes. For the rate of the self-diffusion in molten lead, namely, of thorium B in molten lead, close to the melting point, the value found was 2 cm.<sup>2</sup> day<sup>-1</sup>. In the solid metal, however, after heating a bar, the upper part of which was composed of radio-lead, for about a year at  $280^\circ$ , and then analysing the lower part with the electroscope, no diffusion could be found. It was, therefore, concluded that the self-diffusion in solid lead is, even at this high temperature, certainly less than  $10^{-4}$  cm.<sup>2</sup> day<sup>-1</sup>.

To increase the sensitiveness of the method, we prepared in the present work two thin foils, one of ordinary lead, the other with lead containing thorium B in homogeneous mixture, and pressed these together *in vacuo*. The thickness of the inactive foil was chosen slightly greater than the range of the  $\alpha$ -particles to be measured; therefore no scintillations originating from the radioactive lead could be observed when investigating the inactive foil. But, on heating the aggregate of the foils, a diffusion of the active lead into the inactive one took place and the  $\alpha$ -particles due to the diffused atoms or their successive products of disintegration produced scintillations on the observing screen. By comparing the number of these scintillations with the number of scintillations produced by the active foil at the beginning of the

experiment, the rate of self-diffusion in lead was determined. The following values were found:

$t^\circ$	$D$ in cm. <sup>2</sup> day <sup>-1</sup>	$t^\circ$	$D$ in cm. <sup>2</sup> day <sup>-1</sup>
$260^\circ$	$6 \times 10^{-7}$	$310^\circ$	$5.7 \times 10^{-6}$
$280^\circ$	$1.5 \times 10^{-6}$	$320^\circ$	$4.7 \times 10^{-6}$
$300^\circ$	$2.5 \times 10^{-6}$	$324^\circ$	$1.4 \times 10^{-4}$

The diffusion rate  $2^\circ$  below the melting point is thus only 10,000 times smaller than in molten lead.

As regards the problem of the mechanism of diffusion in a crystal lattice, it seemed of interest to compare the rate of self-diffusion found in lead foils with that observed in single lead crystals. The method used was somewhat modified, to avoid stresses, which might have distorted the single crystal. Thorium B was collected in a hydrogen atmosphere on the surface of the single crystal of lead, and it was observed whether, after heating, a decrease of scintillations could be noticed. A similar method was recently used by Wertheinstein and Dobrowolska, who measured the rate of diffusion of the active deposit of radium in silver, gold, and platinum (*J. de Phys.*, 4, 324, 1923). In our experiments, even at a temperature just below the melting point no diffusion could be detected. We thus conclude that the coefficient of diffusion in a single crystal of lead even at this high temperature is less than  $10^{-8}$  cm.<sup>2</sup> day<sup>-1</sup>. Also, in a lead bar produced by slowly cooling the molten metal, only a very slow diffusion could be observed (about  $2 \times 10^{-8}$ ), while in the case of a suddenly cooled bar a coefficient of diffusion as high as  $10^{-5}$  was determined. A lead foil rolled from the material of the single crystal yielded about the same value as the suddenly cooled bar.

The results found indicate that even the slow rate of diffusion observed just below the melting point is not due to an exchange of place in crystals of appreciable size, but in the "amorphous" material, which is found between the crystals and must necessarily show a less regular structure than the material composing the individual crystals, and thus will be more capable of allowing an exchange in the position of neighbouring atoms.

In a single lead crystal, or in a slowly cooled lead bar even only a few degrees below the melting point, it would take longer, possibly very appreciably longer, than twenty years before an average displacement of the lead atoms to a distance of 1 cm. could take place. The time would amount to many million years at room temperature.

When investigating the diffusion of two very similar metals like silver and gold, or thallium and lead, into each other, we can expect to find conditions not very far removed from those encountered in the case of self-diffusion. By using a foil of thallium and one of active lead it was found that the coefficient of diffusion of lead in thallium amounts at  $285^\circ$ , i.e.  $15^\circ$  under the melting point of the latter, to  $2 \times 10^{-5}$  cm.<sup>2</sup> day<sup>-1</sup>.

On the other hand, when investigating the diffusion of two different metals into each other, much more intricate conditions were to be expected. We determined the rate of diffusion of polonium, which is the highest homologue of sulphur, into both lead foils and single crystals. In contrast to the case of thorium B, the coefficient was found about the same both in the foil and crystal (at  $310^\circ$   $D = 1.3 \times 10^{-5}$  cm.<sup>2</sup> day<sup>-1</sup>). The atoms of polonium thus loosen the lattice of the individual lead crystals and diffuse as if through "amorphous" lead. In this connexion it may be mentioned that, in discussing the discrepancy between the values of the period of decay of polonium found by different investigators, Mme. Curie has put forward the explanation, that during the long time of observation, the polonium in some cases

diffused into the metal on the surface of which it was collected. Recently, Maracineanu (*C.R.* 176, 1879, 1923), working in Mme. Curie's laboratory, has obtained evidence that the apparent period of polonium is appreciably shorter if the lead on which it is collected is heated for a while.

G. HEVESY.

A. OBRUTSHEVA.

Universitetets Institut for teoretisk Fysik,  
Copenhagen.

### Evolution, and the Age and Area Hypothesis.

DR. WILLIS'S assumption that new genera and new species may arise directly by mutation is rather startling to most students of evolution. He supports his contention, chiefly, by the observation that the frequency distribution of genera containing 1, 2, 3 . . . species follows a regular, hollow curve, with monotypic genera the most frequent. Mr. Yule (*Phil. Trans. Roy. Soc. B.* 403) has shown that assuming (1) that species give new species by chance at an irregular rate, constant on the average and the same for all species, and (2) that species give new genera in the same way, by mutation, then the frequency distribution of size of genus will approximate closely to that observed in Nature; the latter being such that log. number of species plotted against log. number of

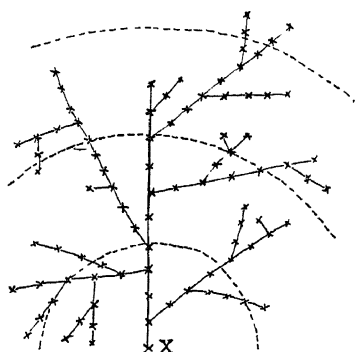


FIG. 1.

genera gives practically a straight line. That all genera arise directly by mutation is implied throughout, since they are all supposed to start as monotypes. Finally, Mr. Yule concludes that viable specific mutations probably do not occur, in all the flowering plants over the whole earth, more often than about once in thirty years; hence that our failure to observe them cannot disprove their occurrence. This conclusion is disquieting; and we clearly cannot accept this mechanism if we can otherwise explain the evidence adduced for it.

It is natural to try to harmonise Dr. Willis's curves with the usual view that genera arise through the extinction of intervening links; and some insight into this question can be obtained by graphical means.

Agreeably with the conventional evolutionary tree, Fig. 1 represents all the species descended from a single species, supposing that none have died out.

We can assume, with some justification, that at increasing distances from the original species (X in Fig. 1) the chance that a species will survive to the present time increases; the survival rate being, for example, 1/3 in the innermost circle, 2/3 in the next, 3/3 in the last. In any area the effect of random extinction of species is shown by numbering the points in the area, taking a random selection of these numbers, in the specified proportion, and deleting the appropriate points from the plan. A distribution

such as that of Fig. 2 is obtained; an isolated point, or group of points, representing a genus.

In an actual experiment, the original number of species was 884, divided into 12 areas by concentric circles; and about one-half the species were exterminated. First, it was assumed that roughly 1/12 survived from the first area, 2/12 from the second, and so on. In a second trial, the corresponding proportions were taken as, roughly,  $a^{11}$ ,  $a^{10}$ ,  $a^9$ , etc. The species were

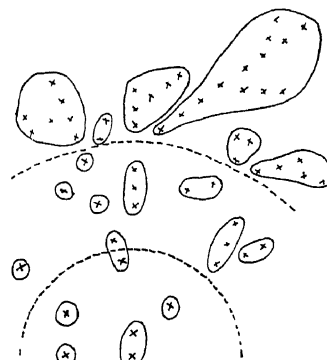


FIG. 2.

then classified by assuming that any point, or group of points, separated from all its neighbours by more than a fixed arbitrary distance, forms a genus. Any other procedure would simply confront us with the ordinary difficulty of the systematist—where to draw the line between two genera. The results for the frequency distribution of number of species per genus, in the two trials, were:

No. of species . . .	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	21	22
No. of genera . . . (1)	78	41	21	10	3	2	1	1	1	1	0	3	1	1	0	0	1
„ . . . (2)	90	45	21	8	5	4	1	1	1	1	0	1	0	1	0	0	1

The curves of Fig. 3 approximate fairly closely to linear form.

It seems likely, therefore, that Dr. Willis's curves accord with the expectation if genera are formed by the dying out of intervening links. The scheme I have given is, I am fully aware, open to objections. Apart from assumptions inherent in the use of a graphical method, difficulty arises over the distance necessary to give a generic gap, the proportion of

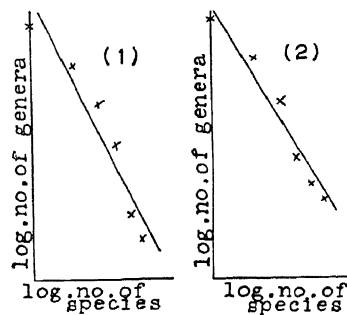


FIG. 3.

species surviving from successive horizons, etc. Such questions it does not seem profitable to discuss at the present time; especially as similar, and other, objections apply equally to the theory of generic mutation. I suspect, too, that the scheme I have given would give similar results with widely different assumptions as to form of the original distribution and the manner of dying out.

A. E. WATKINS.

St. John's College, Cambridge.

### The Growth of Fish.

THE growth of the Brown Trout (*Salmo fario*) can be divided into two distinct phases: (a) the phase during which growth and maintenance are dependent upon the maternal yolk; (b) the phase during which the fish is dependent on external food.

If the eggs are incubated at a temperature of about 10° C. the first phase of growth lasts about 100 days. During this period the embryo grows at the expense of the yolk. At an early stage in development the yolk sac becomes completely cut off from the embryo and the yolk passes, in a soluble form, through the yolk sac wall and is conveyed to the embryo by means of the vitelline veins; as the yolk diminishes in amount the vitelline veins become reduced in size. At no period does any of the yolk enter the larval gut. The eggs hatch on about the 42nd day, but the process of hatching has no detectable influence upon the growth or the metabolism of the embryo.

The respiration of the embryo during the whole of the first growth phase uses up about 4 per cent. of the total yolk, leaving about 96 per cent. for conversion into the embryo. The following figures show the observed rate at which 100 grams of yolk are converted into living tissue.

Days after Fertilisation.	Wt. of Living Embryo in grams.		Observed Amount of Available Yolk.
	Observed.	Calculated.	
<i>T.</i>	<i>W<sub>t</sub>.</i>	<i>W<sub>t</sub>.</i>	<i>Y.</i>
35	8	7	92
40	10	10.5	90
46	17.5	17.5	82.5
50	24	25	76
52	28	28	72
55	35	35	65
60	47.5	46.5	52.5
64	56	56	44
68	64	65	36
71	73	73	27
75	77.5	80	22.5
79	83	86	17
81	88.5	87.5	11.5
82	89	89.5	11
85	92	91.5	8
89	94.5	94.5	5.5
93	96	96.5	4

During the whole of this period two obvious processes are taking place, namely, the increase in the amount of living embryo, and the decrease in the amount of the available yolk. During the first 50 days of development the rate of respiration is strictly proportional to the weight of the embryo (650 c.c. oxygen per kilo per hour), and the rate of respiration doubles itself about every seven days. The observed increment is equivalent to an increase in weight of 10.5 per cent. per day. After this, the rate of growth falls off almost to zero until the day comes when the young fish begins to feed and the second growth cycle begins.

The existence of a second growth cycle is difficult to understand if one assumes with Minot that from the very beginning of development the potential power of reproduction of living tissue is a decreasing entity. A more rational treatment of the data is to assume that the rate of growth depends not only on the amount of tissue already present at a particular instant but also on the amount of yolk available. During the very early stages of development the amount of yolk present does not vary very much,

and the amount of tissue present at any time is given by the ordinary compound interest formula for a daily increment of 10.5 per cent.

$$T \log 1.105 = \log \frac{W_t}{W_0},$$

where  $W_0$  is the amount of tissue at the beginning of the development in 100 grams of eggs. But if the amount of growth also depends upon the amount of yolk present, then the equation becomes

$$T \log 1.105 = \log \frac{W_t \cdot 100}{W_0 \cdot Y_t},$$

where  $Y_t$  is the number of grams of yolk in 100 grams of eggs at time  $T$ . Putting  $W_0 = 0.225$ , the calculated values of  $W_t$  are shown in column 3 of the accompanying table.

The significance of this equation lies in the fact that there are no arbitrary constants. The only value which cannot be checked experimentally is the weight of the embryo immediately after fertilisation. If the calculated value for 100 grams of yolk be correct (namely, 0.225 gram), then the weight of living tissue in a single newly fertilised egg must be about 0.0002 gram.

It may be mentioned that the absence of data during the first month of development is due to the extreme difficulty of handling the eggs at this stage. Although the calculated and observed figures agree very closely, a correction may be necessary if it is found that the percentage of water in the embryo varies from that found in the yolk at different stages of development.

The daily percentage increment during the early stages is greatly affected by temperature, so that the absolute size of the embryo at any time during the first growth phase is determined by the amount of living tissue in the newly fertilised egg, the amount of yolk present, and by the temperature.

Data concerning the second growth phase are not at present available, but it seems quite clear that the quantity of food available plays a very important part in determining the rate of growth, so that the weight of a fish is no criterion of its age. The effect of temperature during this phase is also much less marked, which indicates, possibly, that the potential activity of the living tissue is subordinated to some factor which is not affected by temperature, e.g. the amount of available food. It will be of interest to see whether the relative rate of growth during this growth phase is comparable to that during yolk-sac development when the relative amount of food available for growth is the same in the two cases.

It may be noted that the above suggestions deny any real meaning to such an expression as "a decreasing coefficient of growth." The alternative view is obviously more in harmony with the phenomena of tissue culture and the healing of wounds, although it is not suggested that these things are the result of an increased food supply. They show, however, that the rate of growth of a whole organism has no obvious relationship to its potential capabilities of growth.

J. GRAY.

Zoological Department,  
Cambridge, April 17.

### Formation of Waterspouts.

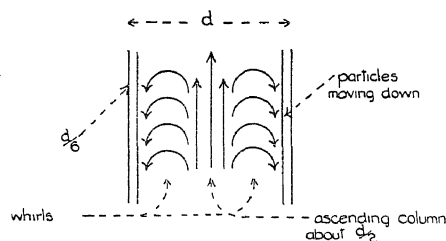
AN interesting observation of a waterspout is reported in the *Marine Observer* of April. The observation was made by Capt. G. Park, of s.s. *Risaldar*. To quote his words: "... The waterspout appeared to be semi-transparent, containing dark irregular masses or shapes. By selecting one or any

mass I counted two seconds for this to revolve and which gradually eased until, when close to the cloud, the same mass revolved once in ten seconds."

This is, I believe, the first occasion on which the period of revolution of a spout has been definitely observed.

The speed of rotation agrees approximately with the velocity put forward from theoretical considerations by Mr. F. J. W. Whipple in the *Meteorological Magazine* for February 1921, but the velocity entailed with this speed of revolution is very high. It would be about 20 m./s. if the spout were 40 feet in diameter, but Capt. Park specially states that this spout was particularly thick and would probably have considerably exceeded that figure.

It is difficult to conceive how so strong a velocity of wind can be generated, especially when it is



d - diameter of spout

FIG. 1.

recognised that waterspouts most frequently form when the wind is very light (force 1 or 2).

The theory, which is, I believe, most commonly held, that waterspouts are the result of eddies formed between two currents of air, does not seem to meet the case entirely, for it implies that the two currents are of great depth, since waterspouts are often of a greater height than 3000 feet, and are seen forming in the cloud while a corresponding disturbance is observed in the face of the ocean. Also, if they were merely formed in a similar manner to the eddies in a mill stream, one would expect to find them in strings of half a dozen or so instead of the frequent isolated instances.

There must, therefore, be a further condition necessary for the formation of waterspouts. It seems that this condition is probably their association with cumulo-nimbus cloud and violent convection, an association which has not been sufficiently emphasised in their discussion.

There are observations in which the ascent of waterdrops in the centre of a partially formed spout has been seen. For example, one made by Mr. V. H. Rozier from s.s. *War Hermit* in the Indian Ocean, in which careful observation showed a section of the spout to be moving as shown in the accompanying diagram (Fig. 1), with the ascending column occupying about a quarter of the horizontal section of the spout.

It seems that this convective property of the central core may be an important feature of the formation of the spout; for, if the lapse rate beneath a cumulo-nimbus cloud were approximately adiabatic, and a patch of air of slightly higher temperature were found near the sea surface, it is conceivable that this warmer air would break through and penetrate up to the cloud. Within the cumulo-nimbus cloud convection will be taking place, and beneath it there will be currents of air drawn into the cloud and expelled from it. By the principle of the conservation of angular momentum, as these currents of air are sucked into the elementary vortex formed by the ascent of the patch of warmer air, they will increase

the velocity of rotation until a complete spout is formed by the lowering of pressure at the centre of the whirl.

It is significant that waterspouts are very transitory, only lasting for about 15 minutes, which would seem to be the time taken for the warm air to be exhausted.

C. S. DURST.

2 Abbey Gardens, N.W.8.

### Chromosomes in *Avena*.

WINGE (*Hereditas*, 5, pp. 241-286, 1924) has recently shown that irregular chromosome conditions, somewhat different from any previously reported, occur in certain aberrant forms of wheat. A cytological study of "false wild oats" begun here last summer has shown chromosome conditions in at least one homozygous strain of this "fatuid" form of *Avena sativa*, L., to be very similar in many respects to those reported by Winge for a homozygous "speltoid" form of wheat.

More than thirty plants have been investigated from a strain of homozygous fatuid oats of the white-seeded, spreading-panicle type. The reduction-divisions of the pollen-mother-cells appear to proceed normally in the majority of cases, but the following irregularities occur with apparently significant frequencies:

(1) In diakinesis, instead of the normal 21 pairs, there may be (a) 19 normal pairs and one ring, or figure 8, or other combination of four chromosomes; (b) 18 normal pairs and two rings, or other combinations of three chromosomes each.

(2) The heterotypic mitosis often proceeds very irregularly. Precocious chromosomes are found at the poles before the remainder have left the equatorial plate. Loops of three or four chromosomes are of common occurrence. Odd chromosomes may be found lagging behind the others during the anaphase, but as they usually arrive at the poles in time to be included in the daughter nuclei, micronuclei are formed only very rarely.

(3) It is believed that unequal numbers of chromosomes are sometimes distributed to the two poles, but owing to the lagging it is very difficult to determine this with certainty.

(4) A large proportion of the pollen has been found to be abortive.

(5) The microspores are frequently arranged in rows of four or other unusual tetrad formations.

The reduction-divisions of *Avena sativa*, L., and *A. fatua*, L., have been found to proceed with almost diagrammatic regularity in all cases examined. Numerous counts have shown 21 to be the haploid chromosome number in both species, as reported by Kihara (*Bot. Mag.*, Tokyo, 38, p. 95, 1919). This is opposed to Nikolaewa's report (*Bot. Abs.* 12, p. 403, 1923), of 48 as the diploid number in the root tips.

Winge's theory of the origin of a speltoid form of wheat through faulty conjugation causing an excess of certain chromosomes and a deficiency of others, with the retention of the normal total, may prove to be applicable to this fatuid form of oats. Particularly attractive is Winge's assumption that, on account of their common origin through polyploidy, the exchanged chromosomes are sufficiently similar to conjugate normally in the majority of cases, but sufficiently dissimilar to cause fairly frequent irregularities. The genetic behaviour of fatuid oats is, however, not exactly parallel to that of speltoid wheat.

Before any theoretical conclusions are advanced concerning fatuid oats, the investigation of a number

of very different types of both heterozygous and homozygous forms recently obtained from various sources will be completed. C. L. HUSKINS.

University of Alberta,  
Edmonton, Canada,  
March 19.

### Pinhole Photography.

WHILST the design of the photographic lens has received so much attention of recent years and its performance has reached such a high state of perfection, the possibilities of the simple "pinhole" camera are apt to be overlooked and forgotten. The accompanying photograph (Fig. 1) of the Royal College of Science, which I have taken recently by

Watt's "Index of Spectra." I soon found at  $600.3 \mu\mu$  a very fine antimony line marked 10 s.c., that is, with a power of 10 (the highest) sharp and clear. Placing poles of metallic antimony in my spark forceps, I viewed this line through a flint prism in one of my spectrometers. I found it to be admirably adapted for any measurements of refractive index.

Although I myself think the difference between line D ( $589.7 \mu\mu$ ) and this one ( $600.3 \mu\mu$ ) small when small instruments are concerned, in the case of large telescopes, and where computers wish great accuracy, I can strongly recommend effecting achromatism by equalising focal lengths for this antimony line and the E line, with line A at shortest focal length.

J. WILLIAM GIFFORD.

Oaklands, Chard, April 5.

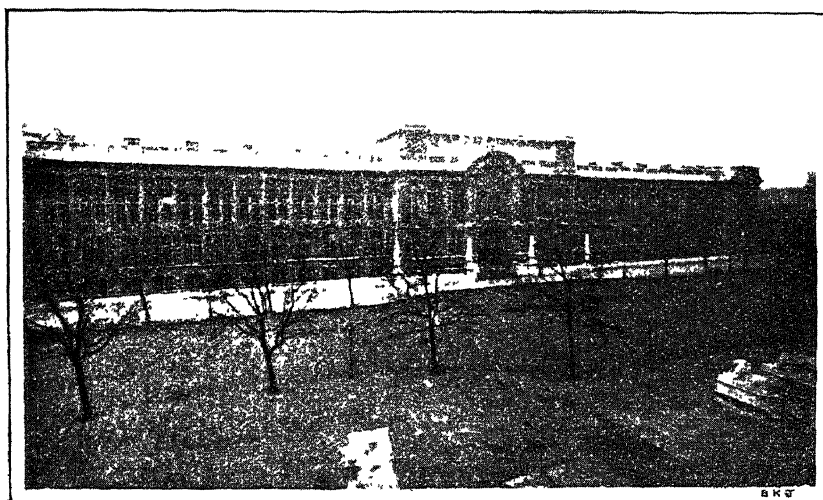


FIG. 1.—Pinhole photograph of the Royal College of Science, South Kensington.

means of the "pinhole" method, may therefore be of interest to readers of NATURE. The following are particulars of the photograph:

Distance of plate from aperture, 8 cm.

Diameter of aperture (using Abney's formula),  $0.35 \text{ mm}$ .

Exposure (sun being obscured by cloud), 7 minutes.

Angle subtended by extremities of building,  $78^\circ$ .

The photograph shows that for architectural subjects (where wide-angle work is necessary) the "pinhole" still stands unrivalled.

B. K. JOHNSON.

Royal College of Science,  
South Kensington,  
London, S.W.7.

### The Choice of Wave-lengths for Achromatism in Telescopes.

REFERENCE to my paper on the above subject was made by Prof. Townsend Smith in NATURE of October 11, 1924, p. 536, and my reply appeared in the issue of November 1. Although fully endorsing his findings, writing then as I did from Cornwall, I was unable to go much further. I have now returned to my laboratory here.

Prof. Smith pointed out that, in order for the minimum focal length to be at  $560 \mu\mu$  (by which I think he meant line A at  $560.7 \mu\mu$ ), instead of combining lines D and E it would be necessary to find a line slightly less refrangible than D for such a combination, and that this line should have for wave-length  $600 \mu\mu$ .

On returning here I looked this up in Dr. Marshall

### The Teaching of Evolution in the United States

THERE appears in the recent translation of Kammerer's "Inheritance of Acquired Characteristics," by A. Paul Maerker-Branden, the following statement:

"Unfortunately, the so-called 'fundamentalists,' led by William Jennings Bryan and clergymen of different denominations—it seems unbelievable, but it is the sad truth—have succeeded in excluding evolution of man from the curriculum of the schools of North Carolina and Kentucky."

This statement is in part, at least, erroneous. Both of these States have recently had bills presented in the legislature to prohibit paying the salary, from State funds, of teachers presenting the theory of evolution as a fact. In each case the bills were defeated; in North Carolina by a vote, as reported by newspapers, of 64-46. Furthermore, the matter was voted on in North Carolina after the publication of this book. The vote in Kentucky was taken a couple of years ago and was closer.

This statement is made in order to "keep history straight."

BERT CUNNINGHAM.

Duke University,  
Durham, N.C., U.S.A.,  
April 18.

### A Curious Survival.

In the days of Galileo, medieval objections to experimental evidence and direct observation were prevalent. Jupiter's satellites, for example, were regarded as trivial deceptive appearances, not worth the trouble of looking at; and one argument against their reality was that they would be useless, and therefore could not exist.

It is interesting, though surprising, to find quite similar arguments still in use, and regarded as at least forensically valid to-day; and those who are concerned with the dissemination of scientific method and interest among educated classes, such as the British Science Guild, would find it instructive to read Sir Herbert Stephen's letter to the *Times* of Saturday, May 2, p. 8.

OLIVER LODGE.

Paris, May 3.

The Pigmentation of Animals.<sup>1</sup>

By Prof. JOSEPH BARCROFT, F.R.S.

THE hue which a person presents depends upon two factors, to denote which no precise words exist, but which may be represented by the general terms *pigmentation* and *complexion*. In man these are quite distinct, and for that reason it is best to start with the consideration of the human skin, and from it to work backwards through some of the more primitive forms of life.

First, then, to obtain a clear idea of pigmentation. It consists in the laying down of a definite deposit of coloured substance in a definite layer of the skin. The pigment is laid down as a more or less uniform covering, it is in the deepest layer of the epidermis, and this fact alone suggests considerations which demand some reflection. "The deepest layer of the epidermis," or Malpighian layer, is that from which all the other layers grow. Its cells are in constant division and the offspring of each segmentation, or the daughter cells, all gradually work their way outwards, taking on certain characters at specific parts of their journey, and, therefore, as all the cells move outwards uniformly, endowing the successive layers of the epidermis with the characteristics proper to the advancing age of the cells.

Although the whole cell moves outwards and ultimately drops off, only the innermost part of the epidermis is pigmented (*i.e.* coloured with the black substance melanin). As an Indian student at Guy's Hospital once said: "We Indians do not shed our melanin." I have never seen a blister on the skin of a negro, but as I understand the mechanism of a blister it is as follows.<sup>2</sup> The lower layers of the epidermis are, like living tissues generally, pervious to water. The upper ones are, in comparison, water-tight. The lower layers become injured and inflamed; thither water is drawn, as to all inflamed areas, and because it cannot get away through the water-tight covering on top of it, the water forces up the cover from the layers beneath. If my conception of a blister is correct, it would follow that the portion of the skin above the blister on a negro would be colourless like our own, whilst that beneath the blister would be pigmented.

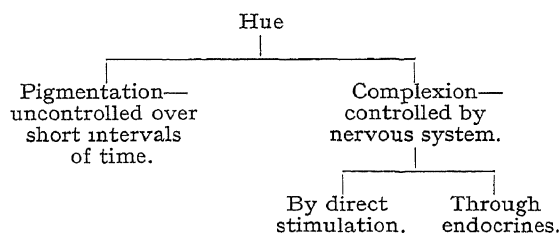
So much for pigmentation. To pass to complexion. By complexion I understand that element in hue which is variable from time to time, the element to which such words as "pale," "fresh," "ruddy," "sallow," "blue," "cyanotic," etc., apply. These words all have reference to the amount and nature of the blood which can be seen through the epidermis. Unlike pigmentation, the pigment involved is not melanin but hæmoglobin; unlike pigmentation, the part of the skin involved is the dermis not the epidermis; unlike pigmentation, the impression of hue is not due to a uniform layer of colour but to the integration of minute vessels; and, most pre-eminently unlike pigmentation, complexion is something which varies from moment to

moment, which reflects the physical condition and the mental equilibrium of the individual.

Complexion then varies (*a*) with the thickness and consequent opacity of epidermis, through which the dermis is seen; and (*b*) with the calibre of the various vessels, arteries, capillaries, and veins of the underlying dermis. Of the veins we know but little as yet; of the capillaries much has been learned within the last six or seven years, and the following table, gleaned from the writings of Prof. Krogh, will give an idea of the relation of the colour and temperature of the skin to the calibre of the arteries and capillaries.

Calibre.		Skin.	
Arteries.	Capillaries.	Colour.	Temperature.
Shut	Shut	Pale	Cold
Open	Shut	Pale	Warm
Shut	Open	Blue	Cold
Open	Open	Red	Warm

Complexion is the expression of the play of the nervous system—in particular the sympathetic system—on the blood-vessels of the skin, but the nervous system can assert itself in two ways, first by direct action, *i.e.* by impulses passing along the fibres which directly supply the blood-vessels; and secondly, by indirect action; *i.e.* by stimulation of one or other of the endocrine glands which in turn secrete an active material into the blood. This material, when it is brought to the vessel wall, affects its calibre. We obtain the following scheme, then, for the factors which influence the colour of the human skin.



Passing from man to the lower mammals we encounter a mechanism which dominates the situation, namely, the growth from the skin of hair. Hair is an outgrowth of the very part of the epidermis which in the negro is pigmented, and therefore the pigment in the hair is of the same order of things as that in the skin. In fact the question arises, quite naturally: "In an animal, which has coloured spots on a white ground, is the colour of the hair on the spots merely the expression of a corresponding pigmentation of the Malpighian layer of the skin from which the hair grows?" If you shave a spotted cat, it is a spotted cat still. But if you go further and cut sections of the skin, there appears to be no pigment in the Malpighian layer; the pigment is confined to the hair roots and the black colour of the spots is due to the visibility of the hair roots, through the epidermis. In the same way the pigment of the scalp of a European, though his hair be jet black, is

<sup>1</sup> Substance of four lectures on "The Colour of the Animal Creation" delivered at the Royal Institution on February 10, 17, 24, and March 3.

<sup>2</sup> In this connexion I am reminded of an interesting example of the ignorance of learned persons on similar points. When I assure myself of the correctness or otherwise of the above view, I ask nine specialists, all of them medical men who had studied blisters, whether the seat of the blister was as I have described it, or, alternatively, was between the dermis and the epidermis. Of the nine, three took the latter view and six the view as given above. We consulted a number of pathology books which were at hand, but without gaining any further enlightenment.

confined to the hair. Presumably you could "change the spots" in the case of the leopard by pulling out all his hairs. But it is not so in all animals. Thus on the spots of the guinea-pig—and, I believe, of the Dalmatian hound—the Malpighian layer of the skin itself is pigmented, and it would look as though this were the more primitive and less specialised condition.

At a superficial view, it might be thought that, the skin being covered with hair, no question of complexion could arise, but this is not altogether so. Complexion, *i.e.* the variable changes in appearance wrought by the nervous system, changes its ground. In animals and birds, the nervous control of the position of the hairs and feathers respectively is a very real affair. In man it is negligible. We talk of our hair standing on end, but the actual phenomenon is not one of great consequence. In animals it is otherwise, and stimulation of the endings of these nerves which are responsible for the lie of the hairs—whether direct or endocrine—may alter the whole appearance of the animal.

One cannot pass the mechanism of pigmentation without some inquiry into its chemical basis: and here we are under a great debt to the late Huia Onslow, who devoted the last years of his life, recumbent as the result of a severe accident, to the study of the chemistry of animal pigmentation.

Put briefly, many of the phenomena are due to melanin, of which mention has already been made. Melanin itself is produced by the oxidation of one of the most common products of digestion, tyrosine, a colourless crystalline material. The oxidation may be partial or complete; in the former case a reddish pigment is formed, in the latter a pigment which appears black in sufficient concentration, but in a dilute form is more or less yellow or brown. The oxidation of the melanin is wrought by a ferment, tyrosinase, and should it not occur, the failure may be attributed to one or two reasons—(a) the ferment is not present, and (b) the ferment is prevented from doing its work by some third substance which overrides it. Either of these circumstances may occur and therefore there are two fundamentally different forms of whiteness. The first, due to the absence of ferment, is albinism; the second, due to the presence of an anti-ferment, is dominant whiteness of the ordinary kind, in which the eyes are pigmented. How different these two forms of whiteness are is shown by the way in which they are inherited. If an albino rabbit is bred with a pure black, the first generation are all black. If a rabbit with the anti-ferment is bred with a pure black, the first generation are all white.

In the chameleon, and more simply in the frog or lizard, is to be seen the complete fusion of pigmentation and complexion. The pigment is to be found in definite cells in the skin, as is the case in the negro. These cells do not, however, form a complete integument, and to these very cells the cutaneous nerve fibres are attached. The colour which the animal presents appears to depend on whether the pigment is diffused throughout the whole cell, in which case the animal is dark, or, alternatively, is concentrated in one locality, in which case the animal is light. Here I must acknowledge a debt of gratitude to two former colleagues, Dr. Alfred C. Redfield and Dr. L. T. Hogben, from one or other of whom I have gleaned most of what I know. Their

work has dealt chiefly with the control of pigmentation by the nervous system, and has shown, in the animals which they have studied, how important is the endocrine factor. In a frog it is only necessary to inject a small quantity of pituitary extract in order to diffuse the pigment throughout the cells in the skin (melanophores), and so make the whole integument darken. In the lizard the same effect is produced by injection of suprarenal extract. In the chameleon the mechanism is more complicated because the pigment cells are more diverse in kind. It must not be supposed that a chameleon can present itself in all the colours of the rainbow. Of two animals which I had the opportunity of observing for about a year, one passed through all shades of brown from a light cream to something short of black, the other through the shades of green from a pale apple colour to a colour so dark as to be barely tinged with green. Let us take the case of the brown chameleon. In the light of modern knowledge, two kinds of cells in its skin may be considered as being the most important. Of these, one kind, the most superficial, were yellow, and probably changed little in colour; the other kind were situated behind the yellow ones, making a background for them. These latter were the true melanophores, and they sent tendrils towards the surface which surrounded the yellow cells. The melanophores were susceptible of endocrine action, presumably having nerve endings on which the endocrine substance could act. When the animal darkened, the black pigment in the melanophores, which hitherto had been localised in small areas, became diffused through the cells, pushing into the tendrils, at once tending to obscure the yellow cells from in front and to provide a background which could be seen through the yellow cells.

Why and when does the chameleon change its colour? The tradition is that it takes the colour of the ground on which it is. This tradition I never could verify, though I well remember an occasion on which the green chameleon got lost on a vine and was very difficult to find. It may be that in our climate chameleons are not very sensitive; just as in the Arctic we might not react very readily to the finer alterations of environment. The fact, however, that my family could make their chameleons darken by annoying them is all in line with the knowledge that their tint is ruled by their nervous systems, as is the human complexion.

Though such factors as heat and cold, light and darkness and mental condition play a large part in the colour changes of the animal creation, it is not intended completely to rule out the idea that animals can simulate the background on which they are placed apart from changes in temperature and illumination. The most remarkable examples of the way in which fish can simulate the backgrounds on which they are placed are proved beyond dispute. A flounder on a dark background will become dark, on a light background it will become light, on a speckled background it will become speckled. Further than this it cannot go; it cannot, for example, assume stripes or definite pattern out of sympathy with its background; and this ability to modify its colour is directly under the control of the actual nerves which go to the skin. It is not a roundabout endocrine mechanism. Cut the nerves

going to a particular cutaneous area, and that area loses its power of simulating the background on which the fish is placed. Here at present the matter must be left until we attain to a more perfect knowledge of what protective coloration really means, for it must always be borne in mind that the object of protective coloration is to save the animal from its natural enemies, and not to save it from us.

What assumption is there that because a fish looks to us the same as the ground on which it lies, it will be similarly protected from its marine adversary, or that it may not be invisible to its enemy though appearing to us to be of a colour very discordant from its background? That such considerations are by no means fantastic may be shown by a very simple experiment. In our own eyes there are two complete mechanisms for the perception of colour; one resides in the rods of the retina, the other in the cones. We can use either

at will, and they see colours quite differently. The cones we use in a light of ordinary intensity, the rods in a dim light. The room is completely dark, there is a blackboard on which are pinned two paper fish. Let in a little daylight—just a little—one fish is seen, it is greyish; a little more light is let in, it becomes brighter, and so with more light until there is some suggestion of the second fish, by which time the first is easily seen. Turn on the electric light, the second and invisible fish at once flashes out, a bright red, whilst the first, which is less obvious, is a royal blue. The switching on of the light transferred the seat of vision from the rods to the cones, but the colour scheme—red on black—which formed a complete protection to the rod-vision became dangerous when the cones were invoked. We need more knowledge of what life looks like to enemy-animals before we can discuss further the adequacy of the colour schemes of protectees.

### The Hebrew University in Jerusalem.

THE inauguration of a new university is an event of interest to all engaged in academic and scientific pursuits, but the opening of the Hebrew University on Mount Scopus, by Lord Balfour, on April 1, aroused more than usual interest, not only among Jews but also among all civilised peoples. The new University is yet in its infancy. At present, a small but well-equipped chemical department is in existence, a micro-biological department is in preparation, a department of Jewish studies is in being, while active preparations are being made in connexion with the Einstein Institute of Physics and Mathematics, the foundation stone of which was laid on Thursday, April 2, by Sir Arthur Schuster. Nevertheless, in spite of its present smallness, the opening of the University was the occasion of a remarkable demonstration of enthusiasm on the part of world-wide Jewry, as well as of sympathy from a large number of universities and learned institutions, which were either represented at the opening ceremony or sent messages of greeting and goodwill.

Palestine is in the process of rebirth, and in all parts of the country there are evidences of great activity in agriculture, industry, and commerce, particularly on the part of the Jewish immigrants who are making Palestine their national home. The University and its associated institutions, like the excellently equipped Technical Institute at Haifa, the Botanical Research Institute at Tel-Aviv near Jaffa, and other institutions of a medical character, must evidently serve the country in the sense of directing the various economic developments. But the most important function of the University, and the function that appeals most to Jews as well as to non-Jews, is to constitute the intellectual centre of world-wide Jewry.

Jews were almost completely excluded from European university life until the nineteenth century, so that Jews figured scarcely at all in the scientific progress of the seventeenth and eighteenth centuries. But as soon as the universities of Europe were opened to Jews, members of this race began to play a rôle of considerable importance in the academic life of civilised humanity. Everybody interested in any branch of science can illustrate this statement for himself with reference to his own subject, and often he will be surprised to discover that men whose names stand in the front rank of

the workers in the subject are of Jewish race or origin. In this connexion it is of interest to refer to the statement made by Lord Balfour at the opening ceremony, when he mentioned the remarkable fact, that the three great theories which have aroused the most general interest in all circles and in all countries, namely, the psycho-analytical theory, the creative evolution theory, and the theory of relativity, are all due to Jews, namely, Freud, Bergson, and Einstein.

While Jews have thus as individuals contributed to the intellectual progress of mankind, it nevertheless remains a matter of speculation as to how much Jewry as a body can contribute to the scientific life of humanity. It will be of the greatest interest to watch sympathetically the young institution on Mount Scopus, and observe in what measure it will tend to increase human resources in the scientific field.

Judging by the very considerable participation in the opening ceremony by the great universities of the world, it seems that there is a considerable amount of confidence in the success of the new University in Jerusalem. So far as Great Britain is concerned, the Universities of Oxford, Cambridge, London, Manchester, Liverpool, Leeds, Edinburgh, Aberdeen, etc., sent representatives to the opening ceremony, while messages of cordial greeting were received from other universities. The Royal Society, the British Academy, and other such bodies, were represented in person, and many others sent cordial wishes.

In the opinion of most people competent to judge, this confidence is not misplaced. In the first place, there can be no question of the existence of a sufficient number of distinguished Jewish men of science to direct the work of the new University. The appointments are being made with very great care and circumspection, and it is gratifying to be able to say that only considerations of eminence in research are allowed to govern the choice of professors and their colleagues.

In the second place, the Hebrew University in Jerusalem is not making the mistake that many lay advisers and critics wanted it to make, of embarking without delay on the task of training doctors, lawyers, engineers, teachers, etc. Palestine itself cannot absorb large numbers of such professional men, but more important still, professional men receiving diplomas

from any institution will find these diplomas of very limited value, unless the institution has first acquired a prestige by the eminence of its teachers and examiners. The University of Jerusalem is therefore at present directing its energies to the creation of schools of research, by the provision of modern equipment and the appointment of able researchers. This policy means slow but sure progress. There is no intention of making a post-graduate university like some institutions in the United States. The intention is to commence with advanced and post-graduate work, leading up to the development of a fully-equipped teaching and degree-giving university.

There are one or two features of the University in Jerusalem which cannot but arouse discussion and even doubtings. The language of instruction in the University is to be Hebrew. There can, of course, be no objection to this on the ground that outsiders will not know Hebrew, because similar objection can be raised to Greek in Athens or to Spanish at Madrid, even to English at Cambridge. The real question at issue is whether the language of the Old Testament is suitable for modern literary and scientific requirements. It is, of course, obvious that the prophecies of Isaiah and the differential equations of the problem of three bodies are somewhat remote from one another. This, however, is a question which has already been solved. Modern Hebrew, while not differing violently from the Hebrew of the Prophets or the Psalms, has nevertheless acquired a flexibility and a resourcefulness that render it perfectly suitable for scientific expression. Many Hebrew books on scientific subjects have appeared in every one of the last ten centuries, and during the present generation Hebrew books and papers on many branches of science have demonstrated how practicable it is to use Hebrew in scientific work. In the secondary schools of Jerusalem, Jaffa, and Haifa, Hebrew has been used for many years, and the same applies to the Technical Institute in Haifa. During the opening ceremonies on April 1, 2, and 3, a number of lectures were delivered by Jewish men of science. One of these lectures on "The Meaning of Causality in Science" and another on "The Principles of Dynamics from Aristotle to Einstein" were delivered in Hebrew, while at a gathering of teachers of mathematics in Tel-Aviv, a lecture was delivered in Hebrew giving an account of a recent piece of

research on the numerical solution of algebraic equations. In all cases it was felt that the use of Hebrew in no way diminished the interest and intelligibility of the lectures.

There is, however, another aspect of this language question. Is it an advantage to introduce into scientific literature yet another language? The scientific worker is already hampered by the fact that he has to read scientific papers in many different languages. This question is no doubt one of considerable importance. But it applies equally to the scientific life of Japan and India, of Russia, Poland, Rumania, Holland, and Scandinavia. The difficulty will be overcome in a similar manner. Scientific papers from Jerusalem will appear in one of the well-known languages of science, like English, French, and German. If these papers will also appear concurrently in Hebrew, this will be no concern of the non-Jewish scientific reader. The "Scripta," or publications of the Hebrew University of Jerusalem, of which a mathematical and physical volume appeared a year or so ago, are an example of this. For internal Jewish purposes it is necessary to use Hebrew on all occasions, and for scientific purposes the Hebrew will not be an obstacle.

It is not necessary to give in the columns of NATURE an account of the ceremonies that accompanied the opening of the University; the daily press has given more or less adequate accounts of these events. But a word must be said here about the remarkable position of the University. From the top of Mount Scopus there is an unparalleled view of Jerusalem—the old Jerusalem with the Temple area, the Tower of David, and other innumerable sites of historic significance, as well as the new Jerusalem which is growing up outside the walls, and which is indicative of the new life throbbing in Palestine. To the east, 4000 feet below, one sees the Dead Sea and the Jordan running into it, with the mountains of Moab and Gilead in the background. These glimpses of sites hallowed by events of traditional value to so large a proportion of civilised humanity cannot fail to serve as an inspiration to teacher and student, to scholar and researcher. The plans for the complete University, prepared by Prof. Patrick Geddes, give promise of magnificent structures in harmonious keeping with the natural contours of the landscape, and with the historical contours associated with Jerusalem.

S. B.

### Current Topics and Events.

THE Huxley Centenary Supplement published with this week's issue of NATURE will, we hope, be judged as modestly worthy of a memorable event. It would have been easy to extend this appreciative survey of Huxley's scientific work and intellectual influence, and we feel that many aspects of these are left unnoticed. The articles which we are privileged to publish are sufficient, however, to show the versatility of his genius and the stimulus which his life afforded to all who came in contact with him, or listened to his message to the modern world. We are fortunate in being able to publish the substance of the Huxley Memorial Lecture delivered by Prof. E. B. Poulton on May 4 at the Royal College of Science, South Kensington. The

lecture originated with the Old Students Association of the College, the president of which, Mr. Herbert Wright, was in the chair, and Sir Charles Sherrington, president of the Royal Society, proposed a cordial vote of thanks to Prof. Poulton for his interesting address. Sir Ray Lankester urges, in his contribution to our Supplement, that the present generation of scientific workers should turn to Huxley's life and essays for inspiration and guidance. No better advice could be given in these days of minute specialisation and the need for the application of scientific methods to problems of national well-being. The following list of works on Huxley, or by him, may, therefore, be of service: "Thomas H. Huxley," by J. Ainsworth Davis (English Men of

Science Series: Dent); "Huxley," by Gerald Leighton (The People's Books: Nelson); "Thomas Henry Huxley: a Character Sketch," by Leonard Huxley (Life-stories of Famous Men Series: Watts); "Thomas Henry Huxley," by Edward Clodd (Modern English Writers Series: Blackwood); "Huxley: a Sketch," by P. Chalmers Mitchell (Putnam's); "Huxley Memorial Lectures to the University of Birmingham," with an Introduction by Sir Oliver Lodge (Cornish); Sketches of Thomas Henry Huxley, in "Problems and Persons," by Wilfrid Ward (Longmans); "Life and Letters of Thomas Henry Huxley," by Leonard Huxley (Vols. 10, 11 and 12 of the Life and Works of Huxley, Eversley Series: Macmillan); "Huxley and Education," by H. F. Osborn (Scribner's); "Impressions of Great Naturalists: Reminiscences of Darwin, Huxley, Balfour, Cope and Others," by H. F. Osborn (Scribner's).

THE agitation against the teaching of Darwinism in the United States, and against the use of text-books which express approval of evolution, has led to the appointment by the Board of Education of California of a committee of the nine Presidents of the State universities and leading colleges. The Board has referred to this committee a series of text-books used in the State with the request that it should report whether their presentation of evolution is such "as to discredit the Bible and to develop in the minds of high school students an attitude of irreverence and atheism." The committee has issued a list of twelve text-books in which, it says, there are no statements derogatory to the Bible, and evolution is presented as a theory—not as an established fact, and in which the treatment is such as "to show due respect and consideration for the fundamental principles of religion, as presented in the Bible." The committee quotes with approval from one of the text-books under judgment as among "Things that Evolution does *Not* Teach. . . . 'That man is descended from a monkey.'" Darwin's statement on this question is emphatic. He declared ("Descent of Man," 2nd edit., 1892, p. 165): The Simiadae divided into "the New World and Old World monkeys; and from the latter, at a remote period, Man, the wonder and glory of the Universe, proceeded." It is significant of the strength of the anti-evolutionary movement in the United States that this committee, the chairman of which is president of the University of California, should endeavour to appease public opinion by its approval of such a misleading assertion, which suggests that the members of the committee are themselves in favour of teaching only a diluted Darwinism.

In the issue for April of the Dutch monthly scientific journal *De Natuur*, H. R. Hoogenraad takes advantage of the centenary of Huxley's birth to write a concise and interesting account of his life and work, accompanied by an admirable portrait. In the introduction he refers to the alternating periods of stagnation and progress in the history of the natural sciences, periods of rapid development being observed at the end of

the seventeenth and the latter half of the nineteenth century; in the former period the empirical collection of facts, in the latter generalisations and formulation of general laws, characterised the progress of science. In the foreground of these generalisations stood the principle of evolution, of which Huxley was one of the foremost champions. The author describes the chief stages in Huxley's career, and gives a summary of the valuable contributions to zoology which marked each of them. He shows how, from 1860 onwards, he became Darwin's chief agent in championing the doctrine of evolution. Huxley's work as a teacher and lecturer is dealt with, and stress is laid on the efforts he made to bring his scientific ideas into the practical politics of the world: "Just as his life stood at the service of science, so did his science stand at the service of life." His whole life was devoted to the fight for the freedom of the human mind. Finally, the author speaks of Huxley's noble character, and of his high standard of life.

A SELECTED portion of the books which originally formed part of the collection presented to the Royal Society in 1667 by Henry Howard (afterwards sixth Duke of Norfolk), and known as the Arundel Library, came up for sale at the hands of Messrs. Sotheby and Co. on May 4. Some of the books reached high figures, notably two Chaucers, which sold respectively for 660*l.* and 560*l.* A Cicero brought 1000*l.* Of the books which were not Arundelian, the chief contest was for Richard Baxter's "Call to the Unconverted," translated into the Massachusetts Indian language and printed at Cambridge (Mass.) in 1664, the only copy known. As mentioned in *NATURE* of April 4, this work was a gift made to the Royal Society in 1669 by John Winthrop, Governor of Connecticut, an original fellow of the Society, and it was sent over by him. It brought the exceptional sum of 6800*l.*, Dr. Rosenbach being the buyer. We understand that the fact of the book being actually the gift of Winthrop, which, of course, greatly enhanced its value in the eyes of American collectors, was discovered more than a year ago by Mr. T. E. James, of the Royal Society's staff. No reference, however, was made to this in Messrs. Sotheby's catalogue, nor was it known, we believe, until it was recorded in *NATURE*, as stated above. The total sum realised by the sale was 14,749*l.*

THE gift of 13,000*l.* from the trustees of the Captain Scott Memorial Fund to the University of Cambridge, to be applied to polar research, reminds us of the generosity of the nation in response to the appeal of the dying leader for assistance for the relatives of the men who died with him. It was from the surplus of the Mansion House Fund of 1913 that a portion was set aside "to aid polar research," and it is the balance not expended by the trustees themselves in that cause which is now handed over to an organisation at Cambridge whose duty it is to foster polar research. The phrase "polar research" should no doubt connote the actual geographical exploration of those regions as well as the study of its special problems, but the amount of the fund will obviously not

permit of monetary help to expeditions about to start, and the Polar Research Institute has to seek other ways in which to perform its function. Some of these have already been begun, and the committee in charge of the Institute will no doubt find others which will be within the scope of its income. But its real success will depend to a large extent on the section of the public which is interested in such matters, for it is upon those who possess records or equipment of past expeditions that one of its chief activities will depend, that is, as a centre for the collection of data and experience gathered at the cost of much labour and hardship in the past, to be used as a reference for the future.

IN theory every new discovery by an expedition to the polar regions should be published to the world, if only as a return for the interest and assistance of the public, to which most expeditions owe their inception. In practice this is usually quite out of the question, both on the score of expense and because it is not easy to say which results are new or important. The effect has been that not only have the observations been dispersed and lost, but also that the work is continually being done over again. Worse still, not a few of the disasters which have occurred are traceable to inadequate knowledge of conditions or equipment quite familiar to former travellers but never made available to their successors. If the Institute, through its collection of records and literature, in print or manuscript, can help to avoid such waste of energy it will have done something worthy of its name as a memorial to one of the greatest of polar explorers. There are other activities for the Institute already planned, such as the provision of rooms in which to "work up" results, the establishment of a museum of polar equipment, the loan of instruments to expeditions and possibly some small assistance in the publication of results, all of which will doubtless be developed according to demand and opportunity. Inquiries should be directed to the Director, Scott Polar Research Institute, Sedgwick Museum, Cambridge, who is naturally anxious to make what information he already has collected available to those interested, and also to accept the care of any records or equipment of past expeditions which can be entrusted to the Institute.

PROF. H. A. LORENTZ, of Haarlem, delivered the fifteenth annual May Lecture before the Institute of Metals in London on May 6. After some introductory remarks on atomic structure, Prof. Lorentz discussed the mean velocity of the electrons when there was an electric current, and showed how Ohm's law could be understood without going into the details of the electronic motions. On the same general grounds an explanation was given of Tolman and Stewart's experiments, by which it was experimentally proved that an electric current in a metal consists in a motion of negative electrons. He then discussed Drude's theory of conductivity for electricity and for heat, insisting on the manner in which the number of free electrons is limited by the value of the specific heat. The remaining part of the lecture was devoted

to the phenomenon of supra-conductivity discovered by Kamerlingh Onnes, and particularly to one of his later experiments, made with a suspended thin spherical shell of lead, in which a system of persisting parallel circular currents had been set up. This shell was placed in an external magnetic field the direction of which did not coincide with the axis of the current system. In these circumstances, if the electrons were absolutely free, the axis of the current system ought to have a precessional motion about the line of force passing through the centre. No trace of such a precession was observed. The conclusion was, therefore, that even in a supra-conductive metal, the electrons are not wholly free in their motion. It seems that definite paths are prescribed for them, along which they can move without encountering a resistance, but which they cannot freely leave sideways.

SIR ROBERT HADFIELD, presiding over the Royal Microscopical Society's conference at Sheffield on April 21, during the presentation of papers on metallurgy and allied subjects, welcomed the important visit of the Society to Sheffield, and at the same time, as a fellow of the Society, thanked Sheffield for its hearty reception. When a visit to Sheffield was mentioned, his thoughts turned to the memory of great metallurgists, many of whom were Sheffield men, and particularly to that of Dr. H. C. Sorby, sometime president of the Royal Microscopical Society—a memory Sheffield always delighted to honour. It was Sorby who inaugurated metallography, not, as often stated, Martens, who began the work fifteen years later. As some of the papers dealt with the question of high magnification, it was interesting to consider what was meant by high magnification work. Very fine structures exist in carbon and alloy steels, particularly when hardened. Magnifications of 15,000, though useful, do not, however, reveal much. To indicate what a magnification of even 8000 diameters means, it may be mentioned that the diameter of the actual field in a  $3\frac{1}{4}$  in. circle photograph is only 0.00041 in. If the photograph were magnified to the same extent, it would yield a circle with an area of roughly 85 acres. With the magnification of 15,500 recently obtained by Mr. R. G. Guthrie, it would be increased approximately to 318 acres. When Sorby's magnifications of nine diameters, which he used in his work on blister steel, are compared with a magnification of 15,000, it can be seen what advance has been made. The late Prof. Howe once said that present ideas on the nature of alloys were due to microscopy. A magnification of 2000 allows problems to be solved which are completely baffling at a magnification of 200. If, however, high magnifications are to be useful to the metallurgist, resolution must also be increased. The good wishes of the meeting were sent, on Sir Robert Hadfield's suggestion, to the veteran metallurgist, Prof. J. O. Arnold, who is suffering from bad health, assuring him that his past services to metallurgy are not forgotten.

DR. CHARLES CHREE, who has been Superintendent of the Kew Observatory for the past thirty-two years,

has retired and is being succeeded by Mr. F. J. W. Whipple, head of the British Rainfall Organisation, Meteorological Office. Dr. Chree has devoted many years to the study of the phenomena of terrestrial magnetism, investigating in particular the diurnal variations which occur. This has led to the discovery of an "acyclic change"; from the averages of quiet days, the mean value of the magnetic force is not the same at the end as it was at the beginning of the 24-hour period, showing a difference which is always in the same direction. Dr. Chree is probably best known for his work on the relationship between terrestrial magnetism, atmospheric electricity and solar phenomena, to which recent volumes of *NATURE* bear full testimony. During the period of Dr. Chree's superintendentship, Kew has become pre-eminent among the magnetic observatories of the world.

ON April 25 the Marconi International Marine Communication Company celebrated its twenty-fifth anniversary. The object of the Company was to develop the use of radio-telegraphy for maritime purposes, and it may well be proud of its record. Within a few months of its formation, it had fitted radio apparatus in twenty-six warships and at six coast stations for the British Admiralty. Its main business, however, is in connexion with the Mercantile Marine. It has installed Marconi apparatus in more than 6000 British merchant ships. Apart from its inestimable value during the War, more than 5000 lives and much valuable property have been saved during times of peace. The Company has trained more than 10,000 radio operators, more than half of whom were on service during the War. A news service to ships was inaugurated from the Poldhu Station in August 1903, and from this the present efficient service of ocean newspapers has developed. In 1912 radio direction-finding was first used, and more than 200 British vessels now carry Marconi direction-finders, elaborate high-speed apparatus is used on board the great liners, but small radio sets are used and are found of great value by trawlers, fish-carriers, and tugs.

In a paper read before the Royal Geographical Society on April 20, Dr. A. Vening Meinesz described his method of determination of gravity at sea in a submarine (*NATURE*, May 3, 1924, p. 641, and April 11, 1925, p. 550), and gave a brief survey of the problems in the investigation of which such oceanic measures of gravity should be of special importance. The first and chief problem of geodesy is the determination of the figure of the earth, in which gravimetric surveys valuably supplement the data given by triangulation. Helmert's, the most recent and comprehensive discussion of the gravity data, led to the result that the equator differs perceptibly from the circular form, a conclusion difficult to reconcile with the theory of isostasy. It is based on land observations of gravity, so that large areas of the earth's surface are unrepresented. Oceanic observations should go far to confirm or disprove Helmert's result, particularly as the sea data appear to be more regular than land measures of gravity, except near

the ocean borders. The second series of problems on which sea measures have an important bearing are those relating to the earth's crust, the stresses to which it is subject, the extent to which it can bear these stresses, and the speed with which it yields to them. There is already some evidence that the principle of isostatic equilibrium is valid for the oceans as well as for the land, but there is as yet no detailed oceanic survey which can indicate what are the deviations from this state. The oceanic data offer two advantages over land observations for this purpose: they will probably be more regular, so that the presence or absence of distinct contraventions of isostasy should be more clearly determined; and since under the oceans there is no erosion and very little sedimentation, two complications which affect the discussion of land gravity data are removed. Finally, Dr. Meinesz pointed out the interest attaching to gravimetric surveys above the edge of the continental shelves.

THE annual meeting of the Royal Society of Canada will be held in Ottawa on May 19-21. In Section V. (Biological Sciences) the presidential address will be delivered by Prof. Andrew Hunter of the University of Toronto, his subject being "Proteolysis and the Structure of Proteins." The programme includes fifty-eight titles grouped under three headings: zoological; medical, physiological, and biochemical; botanical.

THE Scientific Club of Winnipeg has awarded its Research Prize of 300 dollars to Miss Mollie Weinberg for her biophysical investigations in acoustics and on gustatory sensory reflexes, which were carried out in the Department of Physics, University of Manitoba, under the direction of Prof. Frank Allen.

It is stated by the New York correspondent of the *Times* that Mr. Orville Wright intends to present to the Science Museum, South Kensington, the first power-driven aeroplane flown by him and his brother Wilbur. The aeroplane has been taken to pieces and packed in crates ready for shipment from the Wright Laboratory at Dayton, Ohio.

PROF. ELLIOT SMITH will deliver a lecture on "The Taungs Skull—Missing Links" at University College, London, on Friday, May 22, at 5.30 P.M. The lecture will be illustrated by casts and lantern slides of various "missing links." The proceeds from the sale of tickets will be devoted to the St. Christopher's Working Boys' Club, 39 Fitzroy Square, W.1, which is largely maintained and organised by the students and staff of University College. Particulars of the lecture can be obtained by sending a stamped addressed envelope to Miss Husbands, University College, London (Gower Street, W.C.1).

THE managers of the Royal Institution, in association with the Chemical Society, the Society of Chemical Industry, and the Association of British Chemical Manufacturers, will celebrate the discovery of benzene by Faraday, at the Royal Institution, on June 16, the day on which, one hundred years ago, his communication was made to the Royal Society. The

Duke of Northumberland, president of the Royal Institution, will take the chair. After his introductory speech, probably three short addresses will be given by English and foreign delegates, commemorative of Faraday's discovery and its consequences. Delegates from at home and abroad will then be received and their addresses presented. In the evening a banquet will be held in Goldsmiths' Hall. On the previous Friday evening, a commemorative lecture on Faraday as a chemist will be given at the Royal Institution by Sir William Pope.

THE Council of the Institution of Civil Engineers has recently made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1924-25: A Telford gold medal to Mr. Donald Paterson (Johore Bahru); a Watt gold medal to Dr. E. H. Salmon (London); a George Stephenson gold medal to Mr. L. H. Savile (London); Telford premiums to Mr. G. Mitchell (Aberdeen), Dr. T. E. Stanton (Teddington), and Mr. F. E. Wentworth-Shields (Southampton); a Crampton prize to Prof. A. H. Gibson (Manchester); and a Manby premium to Mr. P. W. Robson (Lincoln).

MESSRS. R. FRIEDLANDER UND SOHN, Berlin N.W.6, Karlstrasse 11, issue a monthly bibliography of science entitled "Naturæ Novitates." The list covers much the same ground as that of the list of "Recent Scientific and Technical Books" appearing in NATURE in the last issue of every month, with the addition of the titles of some important papers appearing separately or in periodicals, but no publishers' names are given. "Naturæ Novitates" is now in its forty-seventh year.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: a well-qualified graduate to take day and evening classes in mathematics and to assist in the teaching of physics at the Municipal College, Bournemouth—The Director of Education, Town Hall, Bournemouth (May 30); two student probationers at the Marine Biological Laboratory, Plymouth—The Director (May 30); a technical assistant and a junior technical assistant at the Royal Aircraft Establishment, South Farnborough, Hants—The Superintendent; a principal for the Islamia College, Lahore—The Honorary Secretary, Islamia College Committee, Lahore.

### Our Astronomical Column.

THE SHOWER OF APRIL METEORS.—Mr. W. F. Denning writes: "The display of Lyrids connected with Thatcher's Comet of 1861 returned this year at the usual date, but the meteors were not very numerous.

"At Bristol on April 21 the rate of apparition of Lyrids, during the two hours following 23<sup>h</sup> G.M.T., was found to be about ten per hour. This relates to one observer watching a good sky uninterruptedly. The radiant point was at 272° + 34°.

"Miss A. Grace Cook of Stowmarket observed on April 20, between 21<sup>h</sup> 5<sup>m</sup> and 23<sup>h</sup> 35<sup>m</sup> G.M.T., and saw only two Lyrids. On April 21, between 20<sup>h</sup> 20<sup>m</sup> and 24<sup>h</sup>, twenty-nine meteors were seen, including nineteen Lyrids, and tolerably bright ones at 21<sup>h</sup> 22<sup>m</sup>, 21<sup>h</sup> 42<sup>m</sup>, and 22<sup>h</sup> 38<sup>m</sup> G.M.T. At 23<sup>h</sup> 12<sup>m</sup> a fireball was seen of about twice the brilliancy of Venus.

"On April 23, during a watch of two hours, very few meteors were seen in a splendid sky. At 20<sup>h</sup> 59<sup>m</sup> there was a fireball directed from Virgo.

"Mr. A. King of Ashby, Lincolnshire, watched the sky on three nights and found the radiant point of the Lyrids as follows:

April 20—269°·5 + 33°	7 meteors
„ 21—271 + 33·5	17 „
„ 23—273 + 33	6 „

He observed a brilliant fireball on April 20, 23<sup>h</sup> 38<sup>m</sup> G.M.T., with a flight from 230° - 8° to 231° - 13° in 0·7 second."

CALENDAR REFORM.—Mr. R. M. Deeley, in a letter to the Editor, repeats the suggestion, frequently made before, that one day in each year, and two in leap year, should stand outside the week, so as to make the incidence of week days the same every year. This suggestion was approved by the Committee on Calendar Reform at the Rome Meeting of the Astronomical Union in 1922. But the Union as a whole refused to endorse it. There is, in fact, a widespread dislike to alter the regular sequence of the week days, which has been uninterrupted for something like 3000 years.

There is one suggestion which gives a fixed calendar

without tampering with the week. It is to make the year exactly 52 weeks, and every fifth year 53 weeks. By occasional modifications of the five-year cycle (similar to the Gregorian adjustment) the mean length of the year could be kept right. But the difficulty of adjusting salaries and wages to years of such varying lengths, coupled with the large oscillation in the dates of the equinoxes and solstices, would be grave difficulties, and would almost certainly prevent the adoption of the scheme.

THE OLDEST TRANSIT INSTRUMENT.—In an interesting article on "The Oriental Ancestry of the Telescope" (*Scribner's Magazine*, April), Dr. G. E. Hale, director of the Mount Wilson Observatory, describes the discovery of a transit instrument made by King Tutankhamen. Prof. Breasted, of the Oriental Institute of the University of Chicago, who was working in Egypt in the spring of 1923 at the tomb of Tutankhamen, proceeded afterwards to London, where he found the instrument at the shop of a well-known dealer in antiquities. It is the oldest transit instrument that has yet been found. "It is a rectangular strip of ebony wood a little over ten and one-half inches long (perhaps intended for half a cubit), one and one-sixteenth inches wide, thickness just one-half inch. Along each edge, extending entirely from end to end, is an inscription stating that the object was made with his own hands, by King Tutankhamen, as a restoration of a monument of his father (meaning his ancestor), Thutmose IV. . . . At one end of the ebony strip is a rectangular mortise hole a little over half an inch long, about three-sixteenths inch wide, and a scant one-fourth inch deep. It is clear that this mortise hole contained a tenon holding in place a little block mounted on the end of the ebony strip. To the block was attached a plummet, and a vertical line cut in the edge of the ebony strip exactly opposite the middle of the mortise hole marks the place where the plummet cord descended." In using the instrument the observer looked through the hole, held close to the eye, and noted the moment when certain stars passed across the plumb-line suspended in the meridian.

## Research Items.

**A STATUE-MENHIR FROM TRAMIN, SOUTH TYROL.**—Dr. O. Menghin of Vienna describes in *Man* for April a sculptured stone, now in the Ferdinandeum Museum at Innsbruck, which is from the Tyrol, but unique in that region. It is of sandstone, 181.5 cm. high, 57.6 cm. broad, and 25.77 cm. thick, and is shaped like a column, with square section and triangular top. It is worked superficially to represent a human figure—an armed man, but the face is not indicated. It recalls the statue-menhirs of southern France and upper Italy. The Tyrol example is linked to the Italian group by the occurrence on each of daggers with triangular blades, narrow handles, and circular pommels. The daggers which occur rarely on the French statues are of different type. Similarity to a dagger in the wall painting of Peña-Tu in Spain, usually attributed to the Bronze Age, and the age assigned to the Fivizzano monuments of Italy, suggests a similar date for the Tyrolean menhir. Typologically it is intermediate between the French and Italian types, and is therefore to be connected with the West European culture cycle. It is suggested further that the statue-menhir may represent not a god or goddess of death, but may be the image of persons buried originally at the foot of the monument.

**SCOTTISH ANTHROPOMETRY.**—Prof. R. W. Reid and Mr. J. H. Mulligan have published in the *Journal of the Royal Anthropological Institute*, vol. 54, pt. 2, a study of the stature, head-length, and head-breadth of eight hundred and forty-seven natives of the north-east of Scotland. The material was collected in the Anthropometric Laboratory of the University of Aberdeen. While stature appeared to be a determining factor in head-length, head-breadth depends on the conformation of the skull itself. This was confirmed by a calculation of the cephalic index, the stature tending to vary inversely as the cephalic index. A comparison between natives of the north-east of Scotland and inhabitants of Norway and Sweden yielded some interesting results. Broadly speaking, the Scottish students resembled the Scandinavians in that they were tall and mesocephalic. They were particularly like the Swedes as regards the shape of the head. They were like the Norwegians in shape of face and nose, on the average both features being narrow. No comparison with Swedes was possible from deficiency of observations of these features. The colour of the hair was intermediate between Swedes and Norwegians. The eyes were darker. The Scottish students showed a higher percentage of the Nordic type when pigmentation was disregarded, but, subject to qualification due to certain defects in the evidence, when pigmentation was also taken into account, the percentage of this type in the Scottish material fell below that of Sweden. In all three groups the percentages of Mediterranean and Alpine types were negligible.

**MARINE BIOLOGY AT PLYMOUTH.**—The March issue of the *Journal of the Marine Biological Association* contains papers of wide general interest, both in hydrography and general marine biology. Very notable are three contributions. Mr. W. de Morgan describes (with excellent figures) the marine ciliates living in the tanks at the Plymouth laboratory (there is one new species). This is a paper of outstanding merit and usefulness to zoologists. Dr. Marie Lebour gives a most interesting account of young angler-fish larvæ and their enemies, as studied in a plunger jar in the laboratory; the figures are quaint and very

instructive, and should be used by all teachers. Mr. O. D. Hunt gives results of investigations into the food of bottom-living animals of the Plymouth region. This paper contains an account of special observations, but it also includes a very useful general discussion of modes of nutrition among demersal animals and of the rôle of organic detritus in the feeding of bottom organisms, and it has some very beautiful and interesting photographs.

**ANTS OF THE ADRIATIC REGION.**—Since the year 1908 Dr. Giuseppe Muller has been engaged, at first in conjunction with Dr. Carlo Wolf, who died as a result of wounds sustained in the War, and later with the collaboration of Bruno Finzi, in the classification of the ants found in Julian Venetia and Dalmatia. The results of their investigations, which correct many of the observations made or recorded by earlier authors, are now published in volume 28 of the *Bulletin of the Adriatic Society of Natural Sciences* (Trieste). The catalogue comprises 89 different species and extends to 170 pages, the characteristics of each species, and its habitat, etc., being described in detail. Alphabetical indexes, both of the sub-families and genera, and of the species, are appended, as also is an accessory table by means of which any individual specimen may be accurately placed.

**GENETICS AND WOOL PRODUCTION.**—Prof. A. F. Barker discusses this subject in an address to the Pan-Pacific Science Congress, Sydney, 1923, published in the *Journal of the Textile Institute* and now re-issued. He reviews the history of genetics and points out its importance to the practical sheep-breeder. Several interesting points in the genetics of sheep are brought out. For example, the offspring of a cross between a Lincoln ram and a Merino ewe are said to be gregarious, while those from the reciprocal cross are non-gregarious. This, if confirmed, would be a fact of much interest. In a century of breeding the Merino in Australia, the wool-production has increased from about 4 lb. to 8 lb. or 10 lb. per fleece. It is probable that the wild sheep originally shed its coat yearly, and that man has selected strains under domestication in which this power was lost.

**INFLUENCE OF MAGNETIC FIELD ON BLOOD-VESSELS.**—Recent experiments by the Russian physiologist N. P. Kravkov have shown that an isolated ear of a rabbit, kept in the Ringer-Lock's solution, responds by rhythmical changes in the diameter of blood-vessels to each opening and closing of a circuit connected with an electro-magnet creating a magnetic field near the ear. According to P. P. Lazarev (*Comptes rendus*, Russian Academy of Sciences, 1923) this may be explained on the basis of the ionic theory of excitation. Each opening or closing of the circuit results in an electro-magnetic impulse which spreads in space with the same velocity as light. This impulse may affect the nervous centres in the walls of blood-vessels which influence contraction of the latter, so that the whole process may be explained by the electro-magnetic impulse giving rise to a certain chemical reaction of short duration in the nervous centres, resulting in a pulsation of the vessels. This explanation requires experimental tests, but it is important that further studies of the interesting phenomena discovered by Kravkov should be made along some definite lines arising from the above theory.

**VARIATION IN COCONUTS.**—Volume 13, No. 2, of the *Malayan Agricultural Journal* is devoted to a study of variation in coconuts by Mr. H. W. Jack.

Not only do marked variations occur in the colour, size, and shape of the fruits produced on particular trees, but also in the yield. Other variations are known to occur in root formation, in the thickness and oil content of the "meat," the rate of germination of seed-nuts, and other features, many of which are economically important. Growing side by side under similar soil conditions, trees retain their individual characters. The necessity for greater care in selection is pointed out, and also the desirability of planting seed-nuts only from trees having favourable characters. Frequency curves show the various ranges of variation. The progeny row method is adopted, and the fruiting capacities of these rows will form the basis for more accurate future investigations.

**TIDAL OSCILLATIONS IN THE LAVA PIT OF KILAUEA.** Mr. Ernest W. Brown has recently considered the existence of tidal oscillations in Halemaumau, the lava pit of Kilauea (*Amer. Journ. Sci.*, vol. 9, 1925, pp. 95-112). During an interval of 28 days in 1919, an almost continuous series of measurements was made of the vertical distance below a station on the outer edge of the pit of two points, one on the lava crust near the centre of the pit, the other of the liquid lava in the lake. While oscillations with other periods may exist, the paper is confined to those with tidal periods, namely, 24 h. 50 m. and 12 h. 25 m. Two analyses of the observations were made, and the author concludes, as regards the variations in the height of the crust-lava, that "there is some evidence of tides, with the periods of the lunar day and lunar half-day, with double amplitudes of an inch or so. . . . The variations of height of the liquid lava are too irregular to show small tidal effects."

**LONDON'S ATMOSPHERE.**—The issue of the Journal of the Royal Society of Arts for March 27 contains a lecture by Dr. J. S. Owens on the conditions of the atmosphere over London. While over the North Sea outside Spurn Head there are 140 dust particles per c.c. of air, over London there are on an ordinary winter day 4000 or 5000 and during a fog 100,000 per c.c. During a working day, as shown by the curve published in NATURE of December 15, 1923, the amount of suspended matter in the air over London increases from 6 A.M. to a little after noon and then decreases to a minimum at 6 A.M. It is least on Saturdays and greatest on Wednesdays. The tarry nature of the suspended matter shows that it is due mainly to domestic smoke, as factory smoke is almost free from tar. Dr. Owen estimates that the domestic fire is responsible for about 70 per cent. of the London smoke. Increase of speed of the wind decreases the amount of suspended matter per c.c., and rain brings down with it a considerable quantity of the soluble matter. Although there has been a reduction of about 40 per cent. in the amount of suspended matter in the last eight years, there is still ample scope for improvement, especially in respect of domestic fires.

**IS ELECTRICITY ATOMIC?**—In the April issue of the *Philosophical Magazine*, Prof. Ehrenhaft, of the University of Vienna, summarises his investigations of the past sixteen years, which have all led to the conclusion that the minute particles used in measuring the alleged atomic charge of electricity frequently possess charges which are fractions of that atom. An editorial note which accompanies the paper explains that owing to the interruption of international communications during the War, these attacks on the orthodox position as to the atom of electricity may have been to some extent ignored.

NATURE, however, directed attention to them on August 11, 1910, on January 19, 1911, and on February 8, 1912. In his most recent work Prof. Ehrenhaft uses particles of radioactive substances of radii less than  $3 \times 10^{-5}$  cm. and finds that their individual speeds in the electric field in which they are observed vary so nearly continuously as to imply that their charges vary with time by amounts which are much smaller than the orthodox atom of electricity of  $4.77 \times 10^{-10}$  electrostatic units.

**PYREX GLASS.**—An article on English "Pyrex" glassware, by G. E. Stephenson, appears in *Chemistry and Industry* for March 20. Pyrex glass is a borosilicate glass of high silica content first produced by the Corning Glass Works, U.S.A., as a substitute for Jena and other German glass, supplies of which were stopped by the War. The coefficient of expansion of the glass is  $34 \times 10^{-7}$ , below the limit proposed by the Reichanstalt for first-class glasses for flame protection purposes. This enables Pyrex ware to be made thicker than usual for glass articles, with consequent increase in mechanical strength. English manufacture of Pyrex ware was commenced in June 1923 by the Wear Flint Glass Works; the manufactured articles include teapots, cooking utensils, and such like, besides the more conventional test-tubes, beakers, and flasks. An outline is given of the general methods used in the manufacturing processes. It is considered that the demand for Pyrex laboratory glassware will greatly increase.

**CONVERSION OF STEAMSHIPS TO MOTOR-SHIPS.**—A paper on this subject, read by Eng. Lt.-Comdr. L. J. Le Mesurier before the North-east Coast Institution of Engineers and Shipbuilders on March 27, gives an interesting comparison of the performances of the *Buitang* before and after conversion. This vessel was built in 1916 for the Nederland Steamship Company, and is 417 ft. 8 in. long, with a displacement of 14,000 tons. The original steam plant consisted of triple expansion engines of 3600 I.H.P. at 85 rev. per min. The main engine of the new propelling machinery is a Sulzer two-stroke engine with direct driven scavenge pump, and has a normal output of 3600 B.H.P. at 90 rev. per min. During the official shop trials this engine developed as much as 4390 B.H.P. at 96 rev. per min. during an overload trial. The fuel consumption at normal load was 0.410 lb. per B.H.P. per hour, and the mechanical efficiency was 78.3 per cent. The fuel consumption for all purposes with the original machinery worked out at an average of 1.5 lb. of coal, or 1.1 lb. of oil fuel per I.H.P. per hour; these correspond to 58 tons of coal or 41 tons of oil fuel per day at sea. With the new plant the total consumption per day at sea will be 14.7 tons of fuel. The total annual cost of fuel, including both sea and port consumptions, is 27,780*l.* before conversion and 14,230*l.* after conversion, showing a total annual saving of 13,550*l.* Before conversion the ship could remain at sea 43 days, and after conversion 164 days. Thus, taking in 2000 tons of fuel at Batavia, Java, or other ports, will enable the vessel to complete the round trip to Holland and back, and will permit of 1000 tons of extra cargo on the outward voyage. Staff savings will amount to 1440*l.* per annum. The actual cost of the conversion will probably be 70,000*l.*, and the net saving is estimated at 14,500*l.* per annum—a return of more than 20 per cent. on the capital outlay. Figures are also given for the converted vessel *Wieringin* during a voyage from South America, showing that the speed has been increased by about 20 per cent., despite bad weather, and the cargo carried was about 10 per cent. greater.

## Echo Sounding.

THE extent of the interest which has been excited in foreign navies by the proved rapidity and accuracy of soundings obtained by the method of echo depth sounding is indicated by contributions to the latest number of the *Hydrographic Review*.<sup>1</sup> "Sonic" echo methods, in which the compressional waves sent out from the underwater transmitter are of audible frequencies, are dealt with in part of an article which contains a summary of the results obtained by previous writers in this field, and in an article by Dr. H. C. Hayes, Research Physicist of the U.S. Navy, in which is set forth the theory of three different methods of obtaining depths by sonic echoes. These methods have been described elsewhere and the principles are now well known. Apart from what is known as the "angle method," which is most appropriate to shallow depths, all sonic echo methods reduce to artifices for indicating in a simple and trustworthy manner the interval of time which elapses between making an underwater signal and the return of the echo from the bottom, and methods of avoiding disturbances in the receiving apparatus due to the original signal. A simple device, produced by the Scientific Research Department of the British Admiralty, achieves these objects and has already been described in these columns.<sup>2</sup>

In principle the device is similar to, but differs in an important practical detail from, the Fessenden apparatus described in the *Hydrographic Review*. It is noted that no reference is made in the summary of recent work on depth sounding to the British Admiralty type of sonic sounder or to the simple "Fathometer" of the Submarine Signal Corporation of Boston, Mass., which also resembles the Admiralty apparatus. The writer in the *Hydrographic Review* is in error when he states (on p. 60) that the sonic method can be used only for "rather considerable depths, e.g. 50 fms." According to the above-quoted article in NATURE, the British Admiralty sonic sounder has been used with success in water so shallow that the vessel was only just afloat.

A range of possibilities which will be entirely new to many of those who have studied sonic echo methods is suggested in that part of the article which deals with the use of "ultra-sonic" waves in echo sounding. As the name indicates, ultra-sonic waves are compressional waves of frequency so high as to be inaudible to the human ear. The writer of this section of the report describes apparatus patented by Prof. Langevin and M. Chlowsky for producing these high frequency vibrations, and gives information concerning their properties, which are of great scientific interest.

If we assume that the direction of an object which causes an echo can be estimated with as much accuracy as that of a source of sound, we might imagine that rocks and other navigational dangers could be detected by echoes of sound produced by submarine bells or Fessenden oscillators, and that indications of their direction might be obtained by the use of hydrophones having directional properties, or by the use of some underwater receiving system like the multiple rotating trumpets used for detecting and locating aircraft at a distance by the binaural effect. Theoretically neither idea is impossible, but there are great practical difficulties to be overcome. Since the velocity of sound in sea water is much greater than in air, our underwater "trumpet" system must be about five times as large as a system of similar accuracy in air. Any one who has seen photographs of the air trumpets used in anti-aircraft

work will appreciate the impossibility of fitting such a device under water in a vessel. The idea of an effective underwater analogue to the air trumpet must not, however, be dismissed as absurd, for the U.S. Navy M-V Hydrophone described by Dr. Hayes does for underwater signals what the trumpets do for sounds in air.

Again, for physiological and psychological reasons, it is extremely difficult to obtain the direction of a source of sound (and hence of an echo) with a directional hydrophone unless the sound is continuous, or nearly so, and this introduces the question of effectively screening the receiver against the shocks due to the outgoing signals, in order that the listener may not be so deafened that he cannot hear the comparatively faint echo. It would be very difficult, if not impossible, to devise a method of screening which would be satisfactory under these conditions, and in any case accurate direction cannot yet be obtained with a simple directional hydrophone. There is a further serious objection to the use of sonic echo methods for determining the direction of objects under water. Owing to the long wave-length of audible sounds, very little energy is reflected by a small object, and a floating wreck might thus easily be undetected.

In spite of all the difficulties which beset those who searched for better navigational methods, an idea which originated with Dr. L. G. S. Richardson, soon after the loss of the *Titanic*, has now materialised. Richardson's idea was to project a "beam" of sound from a transmitter fixed in a vessel and to receive the echoes from submerged obstructions. The beauty of the "beam" idea lies in the fact that if an echo is received, then something with acoustic properties different from those of sea-water is known to lie in the direction in which the transmitter is pointing. That is, the source of an acoustic beam acts the part of a searchlight projector, but under water. The difficulty lay in producing a beam of sound, and for a long time the idea remained uninformed.

It is useful here to return to fundamental principles and to remember that the sources of radiation with which we commonly deal are non-directional unless their size is large compared with a wave-length of the radiation emitted, or other steps are taken to concentrate the energy. Mr. Marconi has shown how directional wireless beams can be produced by using what are in effect transmitting antennas of size comparable with the wave-length used. Light may be concentrated into a beam by mirrors because even a very small mirror is many wave-lengths in diameter. Since the wave-lengths of audible sounds are measured in feet, it is clear that it is necessary to use sound sources of high frequency in order to reduce the size of the necessary focussing arrangements to practical dimensions.

It can be shown theoretically that a flat circular plate of diameter about 8·7 inches, vibrating in a direction perpendicular to its plane with a frequency of 40,000 cycles per second (corresponding to a wave-length in water of about 1½ inches), produces a beam of energy with an angle of divergence of about 10°, and containing nearly all the energy passed into the water by the vibrating plate. Now it is clear that a transmitter very much larger than this is impracticable, while use of a lower frequency would reduce the sharpness of the beam. Hence, the designers of sound beam apparatus were faced with the problem of producing an oscillator having a frequency approaching 40,000 cycles per second.

Prof. Langevin and M. Chlowsky discarded electrical and mechanical generators, the use of the effect

<sup>1</sup> *Hydrographic Review*, vol. 2, No. 1, Nov. 1924, pp. 51-121.

<sup>2</sup> NATURE, March 29, 1924, pp. 463-65.

of magnetostriction, condenser-transmitters, high frequency sirens, and whistles—after having tested some and having been told the results of the tests of others—and eventually decided to use the piezo-electric property of quartz,<sup>3</sup> discovered by the Curies in 1880. Quartz, like some other crystals, cut in a particular way with respect to the crystallographic axes, expands or contracts when an electrical potential difference is applied to certain faces of the crystal. This effect is very small for practical voltages and sizes of crystal, and there is a corresponding reverse phenomenon. Thus, if alternating potentials, which may be generated by an ordinary oscillating valve circuit, are applied to a crystal, corresponding mechanical vibrations will be set up in it, and thus energy may be passed into water if the crystal is submerged in the sea. Similarly, the crystal will be strained by any vibrations in the water and the corresponding electrical effects may be amplified and detected by known means.

Now the energy emitted by per unit area of an oscillator of this kind depends, among other things, upon the frequency and voltage of the applied current. To obtain an energy emission of only 1 watt per square cm., alternating potentials of the order of 50,000 volts would have to be applied at a frequency of 40,000 cycles per second, were it not for the fact that Prof. Langevin chooses the thickness of his quartz so that it is in mechanical resonance with the power supply—that is, the thickness of the quartz is equal to one-half wave-length (in quartz) of an elastic vibration of the frequency considered. It is interesting to note the use by Cady and others of this phenomenon of electro-mechanical resonance in piezo-electric crystals in designing frequency standards for wireless and other purposes. Standard oscillators so constructed are small, robust, easily portable, and little affected by normal changes in temperature.

In practice, the oscillators used by Prof. Langevin and M. Chilowsky are stated to have been built up of a layer of pieces of quartz cemented together with insulating compound between two sheets of steel, the whole being arranged so as to be in mechanical resonance with the frequency of the alternating supply. An increased energy emission was then obtained and it was found that the required output could be obtained with only about 2500 applied volts. The oscillators are, of course, specially constructed to withstand both electrical and hydrostatic pressures without breakdown, and sectional drawings of an oscillator and its mounting are given in the article.

It is pointed out in the article under notice that the optimum frequency of transmission is determined by energy losses in the water as well as by the practical limit of size of the oscillator. Energy losses in water increase with increasing frequency, and a formula is given which shows that the amplitude of the compressional wave diminishes with distance according to an exponential law, similar to those which hold for other vibrations passing through absorbing media.

The method adopted to measure the vibrational energy in the water at the high frequencies used in supersonics is interesting. The principle is the same as that upon which the radiometer depends, namely, the relationship between radiation pressure and the energy per unit volume of the medium. The pressures exerted by the supersonic waves were measured by a torsion pendulum in a manner which recalls the use of the Rayleigh disc for obtaining information about the amplitude of air vibrations in resonators.

There appears to be an error in dealing with this

<sup>3</sup> On p. 75, dealing with this point, it is presumed that "Sir E. Rutherford" should be read for "Sir E. Richardson."

question on pp. 60 and 63, in that energy is proportional to the square of the amplitude of the vibration, and the argument on p. 59 relating to the absorption of electro-magnetic and acoustic energy by sea-water is clearly fallacious. Incidentally, the paper appears to have suffered some loss of clarity at the hands of the translators, especially in the theoretical portions. The statement on p. 63 regarding the reduction in energy due to viscosity is worthy of further notice. The conclusion that supersonic waves, having a frequency of 40,000 cycles per second, should travel some 32,000 yards in sea-water before their energy is reduced to one-third of its initial value, taken in conjunction with the statement on p. 83 that a signalling range of 4.9 nautical miles was obtained, suggests that, even with a beam of small divergence, the energy losses over such ranges depend less on viscosity than on the value of some multiplying factor depending on such quantities as the range and beam angle. The value of this factor is not discussed, but some idea of its possible magnitude may be gained from the work of Barkhausen and Lichte reported recently in the *Annalen der Physik*.

The final portion of the paper is devoted to descriptions of the methods which may be used for depth sounding or the location of wrecks, etc., by the ultra-sonic beam. The same oscillator is used for reception and transmission, and can be rotated in its mounting. In one method an oscillograph is used to record the time-interval between the outgoing and incoming signals. In an alternative scheme a fluxmeter is used to integrate a current which flows during the echo interval, and thus a measure of time is obtained. An interesting cross-connected circuit containing two thermionic valves is used to start and stop this current without mechanical relays. It is stated that direct signals have been transmitted with the piezo-electric oscillator over 4.9 nautical miles, soundings taken down to 245 fathoms, and floating bodies located at more than 2000 yards. If the object from which echoes are being received is not the sea bottom but is a floating body, the method gives information both as to its distance and its direction. The latter is as yet unobtainable by sonic methods of depth sounding. But, as direction is generally immaterial in depth sounding, it appears to be doubtful if there is here a large field of utility for what is clearly at present a complicated and expensive piece of apparatus, which would only be safe in skilled hands. Also it may perhaps be permissible to express a doubt as to the results which would be obtained if the supersonic beam were used to detect icebergs. On theoretical grounds it seems improbable that a large proportion of the beam energy would be reflected, because the constants of water and ice which determine the amount of the reflected energy are not notably different.

Whatever may be the limitations of the present device, there is no doubt that, as in many other instances, simplification of design and operation will follow further research, and an aid to navigation of inestimable value will eventually be at the disposal of all who take ships to sea. By the use of the successors of this apparatus the danger of collisions at sea may be greatly reduced, and one is tempted to wonder how many out of the thousands of a future generation of travellers will give a thought to the two scientific workers who, more than forty years ago, discovered the obscure phenomenon on which this method of signalling depends, or to those who have more recently worked out its application. It is a pity that in an age of hurry we are forced to take so many things for granted.

J. B.

## The Microscope in Science and Industry.

A CONFERENCE of the Royal Microscopical Society was held at Sheffield, April 20-22, which was attended by many fellows of the Society and some eighty delegates from other societies. Members of the Conference were received on Monday afternoon at the Town Hall by the Right Hon. the Lord Mayor and Lady Mayoress and in the evening at the University by the Vice-Chancellor.

On Tuesday morning, April 21, the scientific proceedings were opened by an address from the president, Mr. A. Chaston Chapman, who said that he had very great pleasure in presiding over the first Conference held out of London under the auspices of the Royal Microscopical Society. It was his firm belief that the Conference could not fail to exercise a powerfully stimulating effect upon the development of that branch of pure and applied science which it was the special function of the Society to represent. The Society was established in 1839 for the promotion of microscopical and biological science in general. In process of time and with increasing emphasis during comparatively recent years, the microscope has become an essential instrument of research and control in a large number of industries. It is difficult to think of a single industry in which the microscope is not an instrument of almost daily use, and there are many in which it has led to discoveries of fundamental importance. The Society's attentions are not, however, confined to industrial applications of the microscope. The other and older activities have been in no way neglected; the ordinary meetings, as well as those of the Biological Section, are characterised by a vitality which augurs well for the Society's future and for the successful carrying out of the great task it has undertaken. With the introduction of new instruments of research and the continuous development and refinement of the older ones—amongst which the microscope occupies a foremost position—the scientific investigator will find new fields of inquiry ever opening out before him. Many instruments with which the scientific investigator is concerned yield indications which may be described as indirect, it is the main interest of the microscope that it reveals the actual object to the eye, and with certain qualifications necessitated by technical imperfections, and apart from metaphysical subtleties, it can be assumed that what is seen is the thing itself. The microscope would appear to be the only scientific instrument which can claim a Society for its own, and when it is remembered what it has done in the past for human knowledge and its possibilities are considered, it seems worthy of that honour. When it is realised that rulings of more than 100,000 to the inch can be resolved and that the largest molecules such as those of starch or proteins may not be beyond the power of modern ultramicroscopic perception, results may be within reach which even the rashest and most imaginative would scarcely dare to predict.

Some of the papers presented during the morning were read in title only. A joint paper on "The Development of the Use of the Microscope in Steel Works," by Sir Robert Hadfield, Mr. T. G. Elliot, and Mr. G. B. Willey was read by Sir Robert Hadfield. Modern metallography is based upon the observation under the microscope of the internal structure of metals. The paper traced the outline of the development of this application of the microscope and gave examples of its help in works-problems connected with ferrous metals. A comparison of the micro-structure of metals with their chemical, physical, and mechanical properties often shows that microscopic examination affords an economical method of inter-

preting irregularities. A paper by Mr. F. F. Lucas (New York) on "New Facts developed by High-power Metallography" also brought forward some interesting points. The micro-structure of austenite, martensite, and troosite was described; the process of decomposition of austenite and martensite to pearlite, and cold work and regranulation was discussed. Another paper that attracted much attention was one by Mr. J. Ramsbottom on "Some Points in the Life Histories of Yeasts." There is apparently an alternation of generations in yeasts. Endospores either germinate directly and give rise to dwarf forms or copulate in pairs to produce normal colonies. It is possible that some of the numerous "species" of *Torula*, so troublesome particularly to medical men and brewers, are really dwarf forms of *Saccharomyces*. The importance of this to the brewing industry is indicated by the fact that the "Hofbrau" yeast, which is of the typical "Frohberg" type in the normal form, is of the "Saaz" type in the dwarf form. It is interesting to note in connexion with the modern tendency to use light of short wave-length in microscopy that the paper was illustrated by a number of ultra-violet (cadmium) light photomicrographs taken by the late Prof. K. Kruis.

The morning's proceedings ended with the inevitable photograph of members of the Conference. In the afternoon, visits to the works of Messrs. Thomas Firth, Vickers, and Walker and Hall gave a new meaning to the blessed word "steel" to southern biologists. The proceedings on Tuesday were completed by a reception by the Master Cutler at the Cutlers' Hall.

On Wednesday morning the majority of the papers had a "technical" bias. Mr. Conrad Beck advised caution in the interpretation of microscopic images. Examination of a microscopic image with another microscope shows that, due to diffraction, it is a disc surrounded by a few rings of light. Two points are pictured as two discs, a row of points forming a line is a row of overlapping discs or a band of perceptible thickness. A structure of lines is portrayed as a series of bands more or less overlapping and confused. The size of the disc-image of a point is the factor governing resolution. If the band-images of two lines in the object do not overlap, they can be recognised as two elements and are said to be resolved. When the bands are of a thickness equal to their distance apart, they can just be resolved; thus if a microscope has a resolution of  $1/100$  lines to the inch, every detail that it shows will appear to be  $1/100$  of an inch larger than it really is. Resolution is the correct method of describing the sharpness with which a microscope will show an object. The rings round the disc image may generally be disregarded, though under certain conditions they are visible, and many of the sheaths supposed to surround bacteria are really diffraction contour lines. The size of the diffraction disc depends on two factors: the angle of the cone of light collected by the microscope from each point of the object and the wave-length of the light that passes from the object into the object-glass. These factors determine the amount of detail that actually exists in the image—but sufficient magnifying power must be employed to render such detail visible to the eye. The limiting factor of microscopic vision is not magnifying power but aperture and wave-length. Large magnifying power without sufficient aperture is empty magnification. From 1000 to 1500 diameters is as large a magnification as can be advantageously used with anything but ultra-violet light. The use of an immersion lens has the

effect of reducing the wave-length of the light and thus increases resolution. The illumination of opaque objects or dark-ground illumination utilises the whole aperture of a microscope because the object acts as a self-luminous body. With transparent objects the resolution is profoundly influenced by the illumination. The correct method of providing this with a substage condenser was discussed in its various aspects, and its relation to glare and the difficulties of delineating almost transparent structures considered.

Mr. H. Wrighton spoke on "Some Details in Metallurgical Microscopy" and went rather fully into the matter of illumination. Dr. Rogers discussed test objects for metallurgical microscopy. Microscopists have had for a long time a number of test objects by which the comparative merit of a lens can be readily ascertained. To metallurgists, pearlite is most commonly available. For powers of 1000 and upwards, stainless steel was suggested. The final paper was by Mr. W. J. Rees on the micro-examination of refractory materials. There are three methods available. The examination of thin transparent sections by transmitted light by the application of normal petrographic technique. The examination of flat polished surfaces by reflected light, which is difficult to apply on account of the friability of most refractories; the comparative effects obtained by the use of etching reagents such as hydrofluoric acid, are not sufficient to distinguish many common constituents. The examination of powdered materials is especially useful in the examination of silica bricks and of fused alumina-silica refractories.

Sir Robert Hadfield proposed that representations should be made to the Royal Society that the Sorby Research Fellowships should be used for the furtherance of metallurgical microscopy by research on the question of higher magnification and better resolution. The official proceedings closed with votes of thanks to the Lord Mayor, the Vice-Chancellor of the University, Sir Robert Hadfield, and the Local Committee. Parties of members spent the afternoon in visits to the works of Messrs. Hadfields, Cammel Laird, and Joseph Rodgers.

Throughout the Conference an excellent trade exhibition of microscopical and cognate apparatus was open in the Chemistry and Physics Laboratories of the University. Of many excellent and dazzling instruments it would seem invidious to mention any particular exhibit. At the same time a number of novelties attracted a great deal of attention, and in the circumstances it was natural that these should be of particular service in metallurgical work. Messrs. Beck's exhibit included a "Radial" photomicrographic apparatus of great convenience and rigidity. Messrs. Chapman and Alldridge showed some of their vertical illuminators at work, Messrs. J. W. Ogilvy showed amongst other items a 16 mm. oil-immersion objective, and Messrs. Swift a micro-goniometer.

### The "Honey-Sense" of Bees.

A RECENT paper by Frisch<sup>1</sup> records some interesting observations on the manner in which bees notify to members of the same hive the existence of a rich source of honey. By the use of a glass-fronted observation hive and by marking the bees with various combinations of coloured spots, Frisch states that he found that a bee which had just returned from an exceptional source of supply, performed a rapid dance lasting from thirty to sixty seconds. This might be repeated in one or more places in the hive, during which the performing bee

<sup>1</sup> K. v. Frisch, "Stimmen der Natur in der Sprache der Bienen." (Berlin. Julius Springer, 1925).

necessarily came in contact with the surrounding insects, and it was observed that these latter stroked the abdomen of the dancing bee with their antennæ. Afterwards these same bees emerge from the hive and search in ever-widening circles, up to a kilometre away from the hive, for the source of honey the existence of which has been communicated to them in the manner described.

Experiments showed that in this search the bees are in part guided by the flower scent associated with their informant. After collecting their honey-loads they in their turn regain the hive and exhibit the same dancing movements, thereby enlisting additional recruits for the exploitation of their find. But the number of bees thus brought is more or less proportional to the honey supply as, if access to an artificial source of honey is rendered difficult, the returning bees do not dance and no addition is made to the numbers collecting from this source.

From the greater ease which Frisch experienced in training bees to scent as compared with colour, and from the fact that recruits came to scented but not to scentless flowers, he concludes that scent is more important than colour. This view, whilst in agreement with that of Plateau, is at variance with the conclusions of Wery, who found that flowers which were completely enclosed in glass globes attracted bees as readily as those exposed. Frisch's views on the importance of scent and the seat of this sense in the antennæ is difficult to reconcile with Forel's experience that bees from which the antennæ had been removed visited flowers with even greater precision than unmutated individuals. In addition to the flower-scent perceived by recruits as attaching to the returning bees, Frisch adduces evidence to show that the bee possesses a scent-gland by means of which it secretes a volatile substance at the honey source, and this, together with the scent of the flower, guides the recruits to their destination.

Pollen-collecting bees likewise perform a dance when returning from a rich source of pollen, but this is stated to differ in character from that performed by the honey-collectors. Here too the recruits are guided both by the pollen scent and the scent secreted by the recruiting bee.

E. J. S.

### University and Educational Intelligence.

CAMBRIDGE.—The trustees of the Captain Scott Memorial Fund have offered to hand over to the University a sum of about 13,000*l.* for the erection, endowment, and maintenance of the "Captain Scott Polar Research Institute." They suggest that 6000*l.* be set aside for the building and its upkeep, indicating that there are clear advantages in the Institute being a wing of a departmental building; presumably the Trustees have the Department of Geography in mind, and it may be hoped that this gift may stimulate into success the endeavours that have been made to secure adequate accommodation for the Department. The Council is to propose a Grace gratefully accepting the proposed gift.

Lord Ullswater, chairman of the Cambridge University Commissioners, has informed the Vice-chancellor that in order to enable the Commissioners to organise a Faculty system for the University, as proposed by the recent Royal Commission, and also in order to meet some of the most pressing needs of the Library, the Government has increased the annual state grant from 60,000*l.* to 85,000*l.*

Dr. J. H. Jeans, Trinity College, will deliver the lecture on the Rouse Ball foundation on May 11, his subject being "Atomicity and the Quantum Theory."

Mr. C. Warburton, Christ's College, has been re-appointed as demonstrator in medical entomology. Mr. G. F. C. Gordon, Trinity College, and Mr. L. G. P. Thring, Trinity College, have been re-appointed as superintendents of the Engineering Workshops and of the Engineering Drawing Office respectively.

It is proposed by the General Board of Studies that Mr. D. Keilm, Magdalene College, assistant to the Quick professor of biology, be elected a University lecturer in parasitology.

Sir Humphry Rolleston, Bart, Regius professor of physic, has been re-elected a fellow of St. John's College.

Dr. G. E. Moore, Trinity College, has been elected to the professorship of mental philosophy and logic.

EDINBURGH.—Sir Arthur Keith, Munro lecturer in anthropology and prehistoric archaeology for 1925, commenced on May 1 a series of ten lectures on the study of man's evolution as told by his fossil remains.

Mr. F. E. Reynolds has been appointed lecturer in neuro-pathology in accordance with an agreement between the Board of Scottish Asylums and the University. Dr. Henry Wade has been promoted a senior lecturer in clinical surgery.

Mr. W. L. Ferrar, lecturer in mathematics, has resigned on his election to a fellowship at Hertford College, Oxford. Dr. J. E. Macartney, lecturer in bacteriology, has resigned on his appointment as Director of Pathological Services to the Metropolitan Asylums Board.

MANCHESTER.—Applications are invited from British-born subjects, either born in or inhabitants of the county of Lancaster, preference being given to the county borough of Rochdale, for the Sir Clement Roys Memorial scholarship in chemistry, the value of which is 300*l*. The applications must reach the Internal Registrar not later than June 1.

THE development of Indian universities formed the subject of a paper read by Sir Henry Sharp before the Royal Society of Arts on March 6 and recently published in the Society's Journal. The author, who has only recently left the Indian Educational Service after belonging to it for nearly thirty years, has for many years been the chief official adviser of the Government of India in educational matters. He dealt with the subject from the point of view of the historian rather than that of the educational politician, but in the discussion which followed opinions were freely expressed as to the merits of past and current educational policies. It was pointed out that because universities had grown up with a literary bias, technological institutes had not flourished as they should have done. In recent years attempts have been made to develop technical education in subordination to universities in order that technological students may qualify for university degrees. This Sir Henry Sharp regards as unfortunate. He would rather see such institutions as the Sydenham College of Commerce in Bombay growing up along their own lines independently of universities. Sir Edward Gait directed attention to the fact that the vast majority of Indians hold that, whatever else it may be, education must be cheap, and that a university degree, as the necessary passport to remunerative employment, must not be very difficult to obtain. This has led to the abandonment of the promising scheme accepted by the Government of India, before the introduction of dyarchy, for replacing the obsolete Patna College buildings on a crowded site in the heart of the city, where the true university spirit can never be developed, by new buildings on a spacious site outside the city. The plan was abandoned on the ground that it would place an honours course beyond the means of the poorer students.

## Early Science at Oxford.

May 12, 1685. Mr. Ballard gave in an account of Mr. Desmaister's Experiments about ye mixture of spirits of wine with Syrrup of Violets, Milk and Water. It was desired by the Society, that some farther Essaies should be made towards the finding out of the Nature of the Spirits of severall sortes of Wines and other liquors. From these therefore following I have drawn and rectified their spirits, viz: Sacks—Canary, Malaga and Sherry, Rhenish, new and old Hockamore, Pont, white-Wine, and Clarret. These were all distilled, some three, some four times, without addition of any thing, and therefore could not (though in high Bodies, and with a sponge at the top) be quite fined from their phlegm. Every one of these without any discernible difference made a like coagulation of the milk with ye simple and pure spirits of wine. Several of Kunkel's experiments were not found true.

May 13, 1684. Dr. Smith, takeing ye Chair, communicated an abstract of a letter from Paris, which says that there is a Thermometer, lately invented there by Monsr du Val, (whose father, a famous architect, contrived ye church of Val de Grace) which serves to shew ye duration, increase, and diminution of feavors. It is but 3 inches long; 4 or 5 lines in diameter, ye inner pipe, which contains ye refined quicksilver, is onely half a line in diameter.

Letters from Mr. Aston, and from Mr. Molineux, and ye Dublin Minutes were read. On ye account of these Minutes some of St. Cuthbert's beads were produced by Dr. Plot: they were not perfect screw stones (as they are commonly termed) but a conjunction of Annulets; sometimes hollow, (some of which sort have been used as beads) and may be separated from one another, by lying in vinegar. Mr. Molineux is desired to inform us as to ye nature of fiels *i.e.* a Tumor growing on ye extreame parts, and proceeding (as it is supposed) from ye use of whey.

An abstract of a letter from Mr. Heathcott, from Cabo Cors, on ye coast of Guinea, to Mr. Flamsteed, concerning ye Tide on that coast, ye variation of ye needle, &c, was read:

An account of some Injections into ye thorax of a dog, was read by Mr. Musgrave. "On Thursday ye 21st of June 1683, I syring'd 3iij of warm water, into ye right side of a Grey-hound bitch; which caused a great *Rigor*; (especially in ye hinder parts;) a shortness of breath; a heat, or burning, in ye flesh; she look'd heavy; was unwilling to rise, or stand long on her feet; these Symptoms wore off by degrees, so that in a week's time she appeared as well as ever." Similar injections were made on July 2 and 15. "They all went off, and in five days time she seemed perfectly recovered."

"Thus, we see, a quantity of lbij½ of warm water, has been injected into ye middle venter of ye same Grey-hound, within ye space of one month; & if we may be allow'd to judg of her recovery, by a perfect cessation of all Symptoms, as to outward appearance, we must then grant, that this water was carried off thence, in that time; but to give an account, which way it was discharged, (whether by Expiration, Perspiration, Seige, or Urin,) seems very difficult, and is beyond my Anatomy to explain."

Certainly these experiments, as also ye many histories of Empyemas and Dropsies of ye breast mentioned by physitians as cured by large evacuations of urine, doe, in some measure, argue ye probability of a passage or *Ductus* from the thorax, which may convey off thence what liquor arises, either from ye condensation of vapors, or from ye rupture of lymphatics, or any other way in that cavity, mediately or immediatly into ye blood.

## Societies and Academies.

## LONDON

**Geological Society**, March 25.—C. B. Brown and R. A. Baldry: On the clay pebble-bed of Ancon (Ecuador). This bed, varying in thickness from 550 to 900 feet, crops out on the southern shore of the Santa Elena Peninsula, Ecuador. It consists of polished, rounded, or sub-rounded pebbles of harder clay, embedded in a matrix of softer clay, and contains large and partly rounded boulders of sandstone, foraminiferal limestone, grit, polished quartz-pebbles, etc., and masses of limestone. It is considered to be the result of a great post-Oligocene overthrust in soft sands and clays of Tertiary age. The direction of thrusting is from the east-south-east (the Brazilian over the Pacific block).—J. I. Platt: The pre-Cambrian volcanic rocks of the Malvern inlier. The region described occurs about the central part of the Malvern Range, and consists largely of volcanic rocks, which are of pre-Cambrian age, and belong to a distinctly sodic suite comprising sodarhyolites, keratophyres, and spilites. There are a few pyroclastic rocks developed. Although those examined were of an acid composition, there can be little doubt that more basic types also occur. A number of minor intrusions have been injected into the lavas. In the south-west of the area described, two dykes of a comparatively fresh ophitic dolerite crop out, while a subophitic variety of the same type is found in the north-west. There are several dykes and a volcanic neck of epidiorite in the east of the area.

**Aristotelian Society**, April 20.—Jessie White: The relation of pedagogy to philosophy. The science of pedagogy, like other sciences, depends on observation, experiment, and reflection on their results. It starts with assumptions: (1) that immature individuals with marked differences, qualitative and quantitative, can be aided or obstructed in their development by the nature of their material environment and by the actions of the persons with whom they are in contact; (2) that in normal infants there is a powerful impulse towards loving and learning, and these are processes which each child must engage in for himself with suitable help from others; (3) that relatively to the child there is "a ready-made systematised classification of the facts and principles of the world of nature and man" (Dewey), (4) that schooling is only part of the educative process and must be viewed in relation to that wider process.

## MANCHESTER.

**Literary and Philosophical Society**, March 17.—W. W. C. Topley: The bacteriophage phenomenon—transmissible bacterial lysis. The lytic principle is an ultramicroscopic parasite, because it is particulate in Nature, has the power of reproduction through an endless series of subcultures in symbiosis with a sensitive bacterium, and possesses a certain power of adaptation. It is not a living organism, because it can only increase in amount when the sensitive bacterium is actually dividing, a limitation which is not in accordance with most known facts of infection, because it can be precipitated by such agents as acetone or aluminium hydroxide and be recovered in an active form by solution in such substances as acetic acid or ammonia, and because its heat-resistance and persistent activity on prolonged storage suggest a chemical substance rather than a living organism. All the latter characteristics are, however, quite compatible with the active substance being a ferment; but a ferment cannot reproduce itself, so that we should have to believe that the organisms themselves produced more of the ferment when they were

undergoing destruction by it. This mechanism would seem to lead to race suicide; yet the bacteriophage and sensitive bacteria are widely distributed in Nature.

## PARIS.

**Academy of Sciences**, March 30.—Émile Picard: Some singular integral equations.—Ch. Lallemant: A supposed sinking of the soil in France. On the basis of geodesic work by Bourdaloue, done in 1857–1864, and by Ch. Lallemant in 1884–1893, Schmidt has concluded that in the neighbourhood of Lille the ground has fallen by about 1 metre, and this sinking is proceeding at the rate of 25 mm. per annum. This view is accepted by E. Kayser, who considers the differences cannot be regarded as within the limits of the experimental error. A study of the records of the self-registering tide recorders at Brest and at Marseilles does not reveal this difference, which the author concludes must be attributed to systematic experimental errors in Bourdaloue's observations.—Marcel Brillouin: The external field of gravitation and internal densities.—Ch. Moureu, Ch. Dufraisse, and P. Lotte: Auto-oxidation and antioxygen action. The catalytic property is localised in the oxidisable part of the molecule of the catalyst. In the case of sulphur compounds a relation has been established between the oxidisability of the catalyst and its antioxygen action. Thus whilst mercaptan and alkyl sulphides act as powerful antioxygen catalysts towards furfural, the corresponding sulphones are devoid of such action.—P. Widal, P. Abrami, Diaconescu, and Gruber: Digestive hæmoclasis and variations of the neuro-vegetative tonus.—André Blondel: Acoustic selection and radiogoniometry. A discussion of the best means of utilising wireless telephony from light-houses as a means of warning vessels at sea during fog.—E. Mathias, C. A. Crommelin, H. Kamerlingh Onnes, and J. C. Swallow: The rectilinear diameter of helium. The observed values of the densities of the liquid and the saturated vapour of helium are given for nine temperatures between  $-268^{\circ}\cdot38$  C. and  $-270^{\circ}\cdot79$  C. The formula for the rectilinear diameter is  $z = -0\cdot40263 - 0\cdot0017616 \theta$ . The deviations from the straight line are small, although a little larger than those found for hydrogen and neon.—Ladislas Nikliborc: Hyper-harmonic functions.—St. Kempisty: The integration of measurable functions.—Gossot and Liouville: The principles of interior ballistics.—J. Cojan: New extension of the method of zones (Ritchey) to the determination of aberrations outside the axis.—G. Bruhat and M. Pauthenier: The measurement of the dispersion of carbon disulphide in the ultra-violet.—Fernand Prothais: Study of the mixer of gas pumps at low pressure.—Mme. J. S. Lattès: The decomposition into definite groups of the total radiation of radium, by absorption in platinum.—A. Baldit: An alignment of radioactive springs in the region of Velay (Haute-Loire). Out of seventeen mineral springs in this district which have been examined, only three show radioactivity, those of Sembadel, Les Estreys, and Bonnefont, and these three springs are shown to be in a straight line. A fourth radioactive spring (Ceyssoc) was discovered in January 1925, and this is exactly on the line joining the other three.—L. Chassevent: The crystallisation of gypsum and the preparation of plaster of high resistance.—Mlle. J. Lévy and Roger Lagrave: Comparison of the migratory aptitudes of hydrogen and some radicals of the acyclic series.—J. F. Durand and Sherrill Houghton: The reduction of nitro-derivatives by calcium hydride. Calcium hydride reduces nitrobenzene to nitrosobenzene, then to azoxybenzene. Nitromethane gives a calcium salt without reduction.—C. E. Wegmann: The orogenic

phases of the Scandinavian Caledonian chain.—Iovan Cvijic: Karstic types of transition.—Raoul Bélus and Léon Maurel: Magnetic measurements in the south of France.—P. Bugnon: Leaf homologies in the sweet violet.—L. Lutz: The specificity towards their supports of the fungi of the group of *Pleurotus Eryngii*. The growth of the fungus is controlled by the presence or absence of antagonistic substances in the plant: the fungi behave more as saprophytes than as true parasites.—M. Bridel and C. Charaux: Rhamnicoside, a new glucoside, the generator of Chinese green, extracted from the bark of the stem of *Rhamnus cathartica*. Details of the isolation and physical and chemical properties of this new glucoside are given. Its composition is  $C_{20}H_{30}O_{15} \cdot 4H_2O$ , and on hydrolysis with dilute sulphuric acid gives glucose, xylose, and rhamnicogenol. The glucoside in alkaline solutions, in the presence of air and light, gives Chinese green.—Raphael Dubois: The nutrition of the Bromeliaceæ without roots. *Tillandsia dranthoides* (the air flower) has been regarded as a carnivorous plant, but observations are given which prove that this view is incorrect.—G. André and E. Demoussy: The selective absorption of potassium by plants.—Gustave Rivière and Georges Pichard: Comparative trials between the efficacy of nitric nitrogen, employed alone, and ammoniacal nitrogen in the presence of partial soil sterilisers.—M. and Mme. Louis Lapicque: A new demonstration of the equality of chronaxy between striated muscle and its motor nerve.—Jean Delphy: The fixation and contractibility of some Infusoria.—Émile F. Terroine and Jean Roche: The causes of the differences of the intensity of elementary respiration of the tissues.—Mme. L. Randoin and Mlle. A. Michaux: Variations in the proportion of urea in the blood of the guinea-pig under the influence of a diet lacking the antiscorbutic factor.—Auguste Michel: Metamerism and muscular elements in *Scoloplos armiger*.—W. Mestrezat and Mlle. Y. Garreau: Experimental contribution to the study of the transit of electrolytes. Velocity of diffusion through a septum and ionic selection.—Raoul M. May and S. R. Detwiler: The nerve relations of transplanted eyes with the nerve centres in course of development in *Amblystoma punctatum*.—Ph. Joyet-Lavergne: The evolution of the lipoids and the sexualisation of the cytoplasm in the Sporozoa.—H. Foley and M. Brouard: Demonstration of the efficacy of the daily administration of quinine in small doses for reducing the virus reservoir in malaria of natives (Guinea, Sierra Leona).—Edmond Sergent and H. Rougebief: New experiments on the dissemination of yeasts in the vineyard by drosophiles.

## ROME.

Royal Academy of the Lincei, February 28.—Secondo Franchi: The secondary inversion series and the large overthrusts in the Albenga Mountains (Ligurian Alps).—Eduard Čech: Projective geometry of bands of contact elements of the third order.—Francesco Sbrana: A proposition of Almansi.—Giovanni Vacca: Euler's constant,  $C=0.577 \dots$ .—Ugo Broggi: Theory of repeated proofs.—Bruno Finzi: Lord Rayleigh's dissipation function.—Francesco Vercelli: Results of the cruise of the *Marsigli* in the Straits of Messina. The construction of general tables of the currents for nautical purposes is described.—Franco Rasetti: Duration of the quantic state  $2p_2$  of the mercury atom.—Giorgio Piccardi: A thermal method for the study of gaseous systems.—P. Leone: Organo-metallic compounds of aluminium. Aluminium alkyl halides behave similarly to the corresponding magnesium compounds towards ammonia and primary and secondary amines, the hydrocarbon

being liberated and the nitrogen becoming directly attached to the metal.—Arrigo Mazzucchelli and Angelina Vercillo: Preparation of intermetallic compounds by the wet method. Reference is made to a number of instances in which an alloy is formed by the interaction of salts of the component metals in aqueous solution.—Bernardo Oddo: Methylketole yellow. This name is proposed for potassium 2-methylindyl-2-methylindolidenphenylmethane-o-carboxylate, which imparts to wool and silk a bright yellow colour stable towards acids.—U. Pratolongo: Notes on pedological chemistry. (1) The alkalinity of the soil in its relations to the lithological constitution. The high degrees of constitutional alkalinity ( $P_H$  8.8–9.2) exhibited by certain soils are, contrary to what was formerly a common supposition, not derived from calcite or aragonite; possibly hydromagnesite is the determining factor.—Mario Amadori: Hydrated mesotartaric acid.—Antonio Cavinato: Studies on quartz. Corrosion phenomena in a quartz crystal from the Miage glacier (Mont Blanc).—A. Sparta: New species of *Phyllirhoe* (Berg). *Phyllirhoe Sanzoi*.

## VIENNA.

Academy of Sciences, February 19.—G. Kirsch and H. Pettersson: Atomic disintegration by  $\alpha$  rays (Preliminary communication). The H-particles and reflected  $\alpha$  particles given off by 25 elements under bombardment by swift  $\alpha$  particles and at wide angles (about  $140^\circ$ ) with the direction of incidence were investigated by methods previously described. The fact already found for nickel and copper, that the reflected  $\alpha$  particles have a smaller range than that calculated by Rutherford's theory assuming elastic impact, is confirmed for the elements investigated. For all the lighter elements, including chlorine, the reflected  $\alpha$  particles seem to be almost completely missing even at ranges of only 0.5 cm. For vanadium, chromium, iron, selenium, and iodine the departures from the theoretical values are particularly large. Retrograde H-particles have been found with certainty from the elements beryllium, carbon, oxygen, magnesium, aluminium, chlorine, titanium, vanadium, chromium, iron, copper, selenium, and zinc.—F. Hettwer: The viscosity of certain metals. By prolonged torsion of rods of lead, tin, aluminium, and zinc, the effect of viscosity could be distinguished from the elastic after-effect. The coefficient of viscosity for these metals was found to be between  $5 \times 10^{14}$  and  $3 \times 10^{16}$ . For lead-tin alloys no viscosity effect was detected.

March 5.—H. Michel and K. Przibram: Blue zircon from Siam and its behaviour to Becquerel rays. For some years there has come from the neighbourhood of Muang Chantaboon in Siam, some 198 kilometres north of Bangkok, a blue zircon occasionally called Siamese aquamarine. This blue zircon, the crystal form of which is described, develops, when kept in the dark, flesh-coloured spots which disappear in the light. The possibility of these spots being due to radioactivity often associated with zircon made it desirable to study the action of Becquerel rays on this mineral. Under  $\beta \gamma$  radiation the blue changes through flesh colour to dark brown often in striae parallel to certain cleavage-planes. The blue colour is restored by heat and light. Qualitative observations on the radio-luminescence, thermo-luminescence, and radio-photo-luminescence are recorded.—J. Weise: Chrysomelidæ and Coccinellidæ, beetles from the Anglo-Egyptian Sudan, being Part xxiii. of the scientific results of F. Werner's expedition.—H. Wichmann: The ecology of *Xyloterus lineatus*, a wood beetle obtaining its food from symbiotic fungi.

## Official Publications Received.

- Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 45, Part 1, No. 5: The Ionisation of the Atmosphere by Ultra-Violet Light. By W. West and Dr. I. J. P. Part 1, No. 6: The Mechanism of the Opereculum of *Calanus nubilus*. By Dr. John Tait and Dr. W. F. Emmens. Pp. 42-47. 9d. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)
- Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 13, No. 5: The ... (A Study in Pure and Applied Botany) By ... and written by Dr. W. Buins. Pp. 1-12-8 plates. 24 rupees; 3s. Botanical Series, Vol. 13, No. 6: Studies in Diseases of the Jute Plant (2): *Macrophoma corchoris* Saw. By Dr. F. J. F. Shaw. Pp. 193-194+2 plates. 8 annas, 9d. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.)
- Canada Department of Mines: Mines Branch. Investigations of Mineral Resources and the Mining Industry, 1923. Pp. 74. Investigations in Ceramics and Road Materials (Testing and Research Laboratories) 1923. Pp. 75. Investigations in Ore Dressing and Metallurgy (Testing and Research Laboratories) 1923. Pp. 76. Investigations of Fuels and Fuel Testing (Testing and Research Laboratories) 1923. Pp. 86. (Ottawa: F. A. Acland)
- Papers and Proceedings of the Royal Society of Tasmania for the Year 1924. Pp. v+167+22 plates. (Tobart.) 10s.
- Transactions of the Royal Society of South Australia (Incorporated). Vol. 48, Part 1, No. 1. Walter Howchin; assisted by Albert H. Elston. Vol. 48, Part 1, No. 1. 10 plates. (Adelaide)
- New South Wales Botanic Gardens, Government Domains, Garden Palace Grounds, Centennial Park and Campbelltown State Nursery. Report of Director for 1923. Pp. 7. (Sydney: Alfred James Kent.) 7d.
- Union of South Africa. Report of the South African Museum for the Year ended 31st December 1924. Pp. ii+9. (Cape Town: Cape Times, Ltd.)
- The National Physical Laboratory, Teddington, Middlesex. Metrology Department. Verification of Weights, Testing of Balances, Determination of Densities. Pp. 28. (Teddington: National Physical Laboratory) Free
- Annual Report of the Council of the Yorkshire Society for the Year 1924, presented to the Annual Meeting, February 9th, 1925. Pp. 46. (York: Yorkshire Museum.)
- Arkiv för Matematik, Astronomi och Fysik utgivet av K. Svenska Vetenskapsakademien. Meddelanden från Astronomiska Observatoriet i Uppsala. No. 1. 1924. 10 annas. 10d. to the Problem of Determining the Distribution in Space of the Stars. By K. G. Malmquist. Pp. 12. No. 107: Remarks on the Absolute Magnitude Curve. By K. G. Malmquist. Pp. 4. No. 108. On the Correlation between Proper Motions and Radial Velocities. By W. Gyllenberg and K. G. Malmquist. Pp. 36. (Stockholm: Almqvist & Wiksells Boktryckeri A.-B.; London: Wheldon & Sons)
- Department of Education. Bulletin, 1924, No. 1. College Education, 1910 to 1920. Part 1: History and Educational Objectives. Edited by Walton C. John. Pp. vi+51. 10 cents. Bulletin, 1924, No. 40. Legal Provisions for Rural High Schools. By William R. Hood. Pp. 60. 10 cents. (Washington: Government Printing Office.)
- British Legion. Annual Report and Accounts, 1924. Pp. 97. (London: 26 Eccleston Square, S.W.1)
- Smithsonian Miscellaneous Collections. Vol. 77, No. 3: Provisional Solar-Constant Values, August 1920 to November 1924. By C. G. Abbot and colleagues. (Publication 2818.) Pp. 38. (Washington: Smithsonian Institution.)

## Diary of Societies.

SATURDAY, MAY 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—G. L. Bickersteth: Byron and Italian Literature (I.).

MONDAY, MAY 11.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Dr. F. A. E. Crew: Unilateral Vasodilation on the Single Male of the Domestic Fowl. Miss Shema M. ... Nervous System. Studies on ... Perthshire Tectonics: Loch ... Glen Shee

BIOCHEMICAL SOCIETY (at Middlesex Hospital, W.1), at 5.—S. L. Baker: Intra-renal Obstruction caused by the Products of Hemolysis.—R. W. Scarff: Experimental Atheroma in Rabbits produced by Cholesterol Feeding.—O. Rosenheim and Prof. J. C. ... Colour Reaction for the Presence of Vitamin A.—E. H. Lepper and Dr. C. J. Martin: The Influence of Salt Concentrations on the  $\text{CH}_2$  of Buffer Solutions as indicated by the Electrometric and Colorimetric Methods respectively.—H. W. Kinnearley and R. A. Peters: Antineuritic Yeast Concentrates.—L. Gross and P. Eggleton: Note on Blood Sugar Levels in Rats fed on Complete Diets and Diets deficient in Vitamin B.—Dr. T. A. Henry, W. ... and H. C. ... of some Organic ... of Mercury.—F. Dickens, E. C. Dodds, and S. Wright: ... upon the Preparation, Properties, and Standardisation of the Ovarian Hormone.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: Some Effects of Climate on the ... (IV)

BRITISH PSYCHOLOGICAL SOCIETY (at London Day Training College), at 6.—Miss ... Considerations on the Cinema in Education.

ROYAL GEOGRAPHICAL SOCIETY (at Aeolian Hall), at 8.30.—H. K. J. B. Philby: The Dead Sea to Aqaba.

MEDICAL SOCIETY OF LONDON, at 9.—Sir Bernard Spilsbury: The Medical Career of John Keats (Annual Oration).

INSTITUTE OF BREWING (London Section) (at Engineers' Club, Coventry Street, W.1).—H. Abbot: A Review of the ... as applied to Beer.

TUESDAY, MAY 12.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—H. W. Lee: The Principle and Construction of the ...—E. Marriage and others: The Applications of ... Lens.

WEDNESDAY, MAY 13

ROYAL SOCIETY OF MEDICINE (Sub-section of Proctology) (Section of Surgery) (Annual General Meeting) at 5.

ROYAL SOCIETY OF ARTS (Joint with the Royal Aeronautical Society and the Anglo-Batavian Society) at 8.—T. A. T. Van der Hoop: The Flight to the Netherlands East Indies.

THURSDAY, MAY 14.

ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 4.30.—Prof. S. Nicholson: The Malas, an Outcaste People of S. India.

ROYAL SOCIETY, at 4.30.—Prof. E. C. C. Baly and Elizabeth Semmens: The Selective Photochemical Action of Polarised Light. I. The Hydrolysis of ... and H. B. Sifton: Resin Canals in the Spruce (Picea). An Anatomical and Chemical Study and its Bearings on Phylogeny.—H. G. Cannon: On ... Excretory Organs of certain Freshwater Ostracods.—E. G. L. Liddell and J. F. Fulton: Observations on Ipsilateral Contraction and "Inhibitory" Rhythm.—K. Furusawa: Muscular Exercise, Lactic Acid, and the Supply and Utilisation of Oxygen. Part X. The Oxygen Intake during Exercise while breathing Mixtures rich in Oxygen.—To be read in title only.—J. S. Yeates: The Nucleolus of *Tmesipterus Tanniensis* Bernh.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 5.—Annual General Meeting

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. H. J. Fleure: Prehistoric Trade and Traders of the West Coasts of Europe (II.).

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—F. W. Preston: (a) The Fundamental Law of ... (b) The Dimensional Accuracy of Mr. Hampton's Paper on "The Annealing of Glass."—T. Smith: A Note on the Cosine Law.—W. Watson and Sons, Ltd.: Exhibition and Description of Recent Types of Apparatus ... A new Student's Model Microscope, Green ... Attachment for Instantaneous Conversion ... Microscope.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 8 St. Martin's Place, W.C.2), at 8.—P. May: Artists' Colours.

FRIDAY, MAY 15.

ROYAL SOCIETY OF MEDICINE (at ... Section) (Annual Meeting), at 5.—Discussion ... Radiotherapy.

ROYAL PHOTOGRAPHIC SOCIETY (at ... Group), at 7.—Discussion on Art or Truth?

PHILOLOGICAL SOCIETY (at University College), at 8.—Prof. E. Weekley: ... (at Royal ... ) at 8.30.—E. N. Fallaize: Problems in Eugenics, and the Study of ... Races.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. C. G. Darwin: Recent Developments in Magnetism.

SATURDAY, MAY 16

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—G. L. Bickersteth: Byron and Italian Literature (II.).

## FREE PUBLIC LECTURES.

MONDAY, MAY 11

UNIVERSITY COLLEGE, at 5.—Prof. G. Dawes Hicks: Hegel's Aesthetics. (Succeeding Lectures on May 18, 25.)

TUESDAY, MAY 12.

GRESHAM COLLEGE (Pasinghall Street, E.C.2), at 6.—A. R. Hinks: Time-keepers ... (Succeeding Lectures on May 13, 14, 15.)

LIVERPOOL UNIVERSITY, Sir Robert Jones: Crippling due to Fractures: its Prevention and Remedy (Lady Jones Lecture).

WEDNESDAY, MAY 13.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—R. A. Smith: Primitive Man. (Succeeding Lectures on May 20, 27.)

THURSDAY, MAY 14.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: Recent Discoveries in Egypt.

ST. MARY'S HOSPITAL: Institute of Pathology and Research, at 5.—A. T. Glenn: The Principles of Immunity as illustrated by Protective ...

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir W. Watson Cheyne, Bart.: Lister Memorial Lecture.

FRIDAY, MAY 15.

CHARING CROSS HOSPITAL MEDICAL SCHOOL, at 5.—Prof. B. Brouwer: The Projection of the Retina in the Brain.

ST. BARTHOLOMEW'S HOSPITAL MEDICAL COLLEGE, at 5.—Dr. H. H. Dale: Chemical Control of certain Bodily Functions. (Succeeding Lectures on May 19, 22, 26.)

# Supplement to NATURE

No. 2897

MAY 9, 1925

## The Centenary of Huxley.

THE centenary of the birth of Thomas Henry Huxley on May 4, 1825, is an event which may very appropriately be marked in a special way in NATURE. The first issue of this journal, in November 1869, opened with a translation by Huxley of Goethe's rhapsody "Die Natur"—an introduction which compelled thought and the full meaning of which was, therefore, not widely understood. He referred to this in an article entitled "Past and Present" contributed to the issue of November 11, 1894, and suggested that if such a prose poem was not intelligible to many readers it was because "At that time, it was rare for even the most deservedly eminent of the workers in science to look much beyond the limits of the specialty to which they were devoted, rarer still to meet with any one who had calmly and clearly thought out the consequences of the application, in all the regions into which the intellect can penetrate, of that scientific organon, the power and fruitfulness of which, within their particular departments, were so obvious." With the exception of a critical review in the *Nineteenth Century* of Lord Balfour's "Foundations of Belief," the article was the last pronouncement of his faith in biological evolution and the idea of human progress through the use of scientific knowledge. A few months later, on June 29, 1895, he passed into the stillness of death.

So long ago as 1874 Huxley was included among our "Scientific Worthies," and Dr. Ernst Haeckel then gave an appreciative account of his biological work. Some of the aspects of this work are displayed in the articles with which leading authorities in particular fields have favoured us for this commemorative issue of NATURE; and most of our volumes afford further evidence of its value. The range of his papers extended literally from Medusæ to man, and at both these limits his observations and interpretations endure as permanent points of reference. He was only twenty-five years of age when he returned from his voyage as assistant surgeon and naturalist on the surveying ship *Rattlesnake*, yet his work was of such merit that he was elected a fellow of the Royal Society in the following year, and at twenty-seven was a Royal medallist, member of the Council of the Society, and in the very front of British scientific men. The hundred or so papers recorded in the Royal Society Catalogue, and the four volumes of his collected scientific memoirs, are a sufficient

monument of his original contributions to science, without reference to his essays, addresses, and other publications.

However great the significance of this work, Huxley's influence extended far beyond the field in which it was understood. In the mind of the public he takes his place among great thinkers not because of his scientific papers but because of his advocacy of the use of scientific methods and results. "There are," he said, "two things I really care about—one is the progress of scientific thought, and the other is the bettering of the condition of the masses of the people by bettering them in the way of lifting themselves out of the misery which has hitherto been the lot of the majority of them." It is not often that a scientific leader associates himself so closely with problems of citizenship and civilised society; and there are some who think that the time devoted by Huxley to mankind might have been given more profitably to science. If he had done so, the list of his original papers would have been extended, but public recognition of scientific truth would have been delayed for a generation. For the intellectual freedom and social position which we possess to-day, we have to thank Huxley's public work, and not his contributions to the publications of learned societies.

Just as light is invisible until it comes in contact with matter, so scientific discovery has to touch human life before the majority of people can see it. Huxley made science of human interest whether he was describing a piece of chalk or applying scientific methods to considerations of social advance or religious doctrine; and it is on this account that his memory is cherished wherever men believe in progressive knowledge and the making of their destiny through it. There is no one to-day upon whom his mantle may be said to have fallen, yet the need of declaring his message is as great as ever it was. What was once a gospel to be proclaimed from the housetops has become almost an esoteric cult, and its disciples leave the throbbing world outside their temples to look after itself. There is plenty of didactic science, but little of the vital spirit of scientific truth or of the guidance which scientific methods may afford the community. The best tribute that could be paid to Huxley upon this occasion of his centenary would be to follow him along the road he trod so fearlessly with his face always towards the light.

**Home Memories.**

By LEONARD HUXLEY, LL.D.

THE editor of *NATURE* asks me for some personal reminiscences of my father in commemoration of this his centenary birthday. Vivid indeed are those memories across the intervening years; vivid as the afterglow on the mountain peaks above the valley on which night has fallen. Among the wavering, inconsequent recollections of childhood he seems to stand as the ultimate pillar of the house; the power, rarely invoked but irrevocably right, which lay behind the round of daily governance, and, all question of personal affection apart, was hedged round with something of the awe of decision and the majesty of infallible justice. The keen eye, the firm lips which could be severe as well as tender, demanded the wholesome sincerity they offered. I do not believe any one of us seven ever tried to "get round" him, not even (I speak under correction) my youngest sister, who enjoyed, and I fear was sometimes encouraged by us to trade upon, certain privileges as the babe of the family.

His influence upon those familiarly close to him was due to the fact that he was thus sincere and true in word and deed, not that he talked about sincerity and truth in large phrase or "high-falutin" platitude. It was enough that word and act were winged with such attributes. They worked of their own essence from within, where abstract preachments might well have been unable to penetrate and perhaps provocative of reaction.

But if we knew how firm that decision of his could be, we knew also its constancy and lasting support. It was a thing that awakened along with awe, not sulks, but respect.

The companionship between parent and child, so prevalent to-day, was unknown a century ago and rare fifty years since. Though he had a great love for children, my father saw less of his own than he could have wished. In the endless rush of his strenuous life he left home early and returned late. The day was filled, and overfilled, with professorial work in the lecture-room and the laboratory; with Royal Commissions and the affairs of learned societies, and later, the School Board, punctuated with meetings of societies and public lectures and addresses and some measure of social intercourse with his friends, among whom his warmth and brilliance were always welcomed. Every spare moment of the day that could be found was devoted to his own researches; the nights he was at home he was back at his books or his writing by half-past eight for three or four hours, at one period winding up the day with a long read in bed at some stiff work on philosophy. If Sundays brought relief from profes-

sorial duties, they offered certain free hours for writing, and when the summer holidays took us all to the sea, the mornings were always spent in steady work. In fact, so curtailed were his home hours when we were children, that he used humorously to describe himself as "the lodger."

Still, there were many Sunday mornings, more often, it seems to me, than Sunday afternoons, when in the early 'seventies he used to take us three elder ones a cheerful walk, either up the green lanes, as they then were, that led to Hampstead Heath, or to the more thrilling delights of the Zoo, where his position in the Society and his frequent collaboration with the Prosector, made him well known to all the officials. Under his ægis we were sometimes given baby lions to pet, or taken into the inner rooms of the monkey-house and allowed to walk hand in hand with pleasant chimpanzees which were too delicate to be exposed to the infectious perils of the open monkey-house before the secrets of tuberculosis were discovered.

On these walks, whether in town or country, he never laid himself out to be didactic, after the model of Mr. Barlow or of one scientific friend of his own, who, I fancy, sometimes induced the wrong kind of reaction in his children by what they felt was unseasonable instructiveness. Not but what we picked up various golden crumbs casually; sea stories we might have, and tales of animals, and occasionally geological sketches suggested by the gravels of the Heath; only these things were not openly pressed upon us. I know that he wanted us to grow along our own intellectual bents, and had a real horror of forcibly bending the twig from without by untimely pressure of his own special interests. At all events, what we got provoked interest, not reaction. I have no doubt we could have borne more without reaching the saturation point he dreaded.

Even in the earlier days of hurry and stress, memory recalls precious quarters of an hour before bedtime when he drew pictures for us, for he was, if untrained, a skilful draughtsman by nature, either in pencil or with coloured chalks on brown paper. Curiosity was kept on the tenterhooks of fearful expectation; if we clamoured to know what was coming next, there was the invariable warning that the pencil might take control and produce something portentous and unspeakable. It was an unforgettable disappointment when, one evening during convalescence after scarlet fever, I fell asleep too early and missed the eagerly looked-for chapter in the veracious history, so richly illustrated, of Mr. Bull Terrier and his family on holiday at the seaside.

Dinner on Christmas Day had a joy of its own, for before our eyes he invariably carved wondrous beasts out of orange peel, mostly pigs with crooked legs, but also elephants and well-paunched apes. At the time when Whistler was stirring the Academic pool with his nocturnes and harmonies, one of these masterpieces was solemnly ticketed "A Piggurne, or a Harmony in Orange and White."

The published letters offer touching evidence of his own love for children and of his realisation of the part they play in the life of the human affections. Two in particular stand out: one to Charles Kingsley on the death of his own little boy; the other to his eldest daughter when her child died.

In the years of his retirement and greater leisure, his grandchildren came in for these good things. Congratulating a friend on the birth of a grandchild, he wrote: "I forget whether you have had any previous experience of the 'Art d'être Grandpère' or not—but I can assure you, from 14 such experiences, that it is easy and pleasant of acquirement, and that the objects of it are veritable 'articles de luxe,' involving much amusement and no sort of responsibility on the part of the possessor." Unhampered by circumstance, his love of children brimmed over with merry nonsense and suggestive good sense. I always like the story of how a visitor arrived to find him on hands and knees with a big sheet of paper spread out on the floor, drawing a plan of the solar system for a small grandchild. And what could be more perfect of its kind than the letter about the Waterbabies to his yet smaller grandson, with the hope that he also would grow up to be "one of the great-deal seers"?

True, perhaps, that a shy child, conscious of the gulf between what happens and what ought to happen, and distrustful of his own powers, might be more acutely aware of the awe and authority which invested his rare presence than of the comparatively reticent affection that became better known afterwards. Afterwards, too, one learnt that with all his strictness against moral lapses, he could make pitiful allowance for the temptations of nature and temperament.

I think that of all forms of immorality—and naturally he avoided that unscholarly euphemism which delicately restricts the word to the least delicate breaches of the moral code—he hated most the lie, dishonesty of word or act. Veracity he felt and knew to be the very foundation not only of intellectual but also of moral and social life. Firmly and inevitably he broke off relations with people whom he found he could not trust, no matter how close their former association, or how powerful their influence in the world where he moved. Indeed, against a lively talker who argued that truth was no virtue in itself, but must be upheld for expediency's sake only, he declared him-



Photo]

1857.

[Vaul and Polyblank.

self to be "almost a fanatic for the sanctity of truth." Even a noble perjury like that of John Inglesant for his king, was a "moral suicide." If a man allows himself to be believed worse than he actually is, it is a loss to the world of moral force, which cannot be afforded. Yet I remember once, when the conversation turned on the occasions when lying might conceivably be justified, he confessed that it would be very difficult not to permit a lie in defence of a woman's honour, and a letter speaks gently of writing more generously of a dead man than his strict deserts for the sake of his widow.

Nor was this love of truth, when the clash came, applied only against others. If he found he had made a mistake, he admitted it frankly, without hedging or qualification. As he said on one occasion, "The most considerable difference I note among men is not in their readiness to fall into error, but in their readiness to acknowledge these inevitable lapses."

The fanatical person, the slave to creed or habit, has but a one-way traffic of mind. His logic has become inflexible; it may not be turned against himself. This at least was not my father's way, even in regard to the conventionalised acts of social life which unreasoning habit tends to make sacrosanct. True that social conventions, the courtesies and decencies of life, originally based upon valuable controls of our turbulent nature, however much they were exaggerated by that estimable lady Mrs. Grundy, meant much to his orderly conception of daily life. Though he would fight resolutely against the tyranny of the untrue, the irrational, and the cruel, disorder for its own sake, repudiation of the debt we owe to the society which has made our life possible, found no favour in his eyes. Still, let it once be shown that there was no sound argument against the breaking down of some conventional habit, as, for example, that his daughters should not smoke equally with his sons, he put aside his prejudices fairly and squarely, admitting that they were merely conventional.

In these things, as in other difficulties, his motto was: Grasp the nettle. A passive responsibility must be faced as promptly as an active one; and when responsibilities came his way, he was always ready to shoulder them. A subconscious knowledge of this, I think, must have contributed to our sense that he was always a bulwark in case of need.

In trying to analyse one's youthful feelings towards him, I think it was this living intensity of the passion for veracity which was at the bottom of the sense of awe that crept, as I have said, into our regard. Before that intensity anything weak or shuffling or insincere shrivelled painfully away. With that quality went the clearness of decision and readiness to accept responsibility which we knew, and which was reflected in his abhorrence of anonymity in written criticism; a rapidity of thought that flashed to sight of a conclusion even before it had seen all the intermediate steps; an eye that, reading at railroad speed, would tear the heart out of a book and store in the mind the substantial points of value to himself together with remembrance of the place where they might be found again for fuller reference; a fiery energy which slow-moving colleagues found almost terrifying. He had a quick temper, swiftly moved by injustice, ill behaviour, ignorant aggression, or the sight of cruelty; withal he had no

smallest trace of bad temper, of sullenness or grudge-bearing. Malice could not exist with the bubbling sense of humour which never deserted him, nor empty rudeness with his strong self-respect. Certainly his retorts could be devastating, but they were neither unprovoked nor after the fashion of Dr. Johnson, knocking his opponent down with the butt end of the pistol after he had spent all his ammunition. They had a deadly keenness and kept close to the point at issue.

Certainly, also, he did not suffer fools gladly, and he was much pestered by them all his life. Yet there are compensations even in this, for, as he exclaimed, "Of the few innocent pleasures left to men past middle life, the jamming common sense down the throats of fools is perhaps the keenest."

To do this with a neat turn of fence and a dash of humour or polished irony afforded him real artistic satisfaction. For the artist in him was very strong;—the sense of form and proportion which give not only beauty but, to a missile, penetration and to a structure, balance that is easily comprehensible. The eye which, had he followed a latent bent towards mechanics, would have made him at once engineer and architect, was quick to group his materials in their relations one to another, to seize on the essentials and to create a whole inevitably lucid, convincingly clear, which, though warmed with generous thought and enriched with wide knowledge and a clarity of words to match the clarity of ideas, seemed to be the unrolling of Nature's self for all to read; something, as it were, independent of the mere writer, something superior to the literary posturings of too many interpreters of the universe. In this sense he had the style that Buffon declared was part of a man's self, a thing that depends on inward grace, not on outward graces and laborious embellishments. Vision and expression were alike in their directness, their fullness, their clarity, their freedom from the top-hammer of the unessential. It was this quality in his lectures that led a certain literary lady and friend of the house to ask my mother why it was that his lectures were so highly praised. For her part, it seemed that he just explained the subject, and that was all about it. I do not think he ever desired higher praise than that left-handed compliment.

As to his mode of writing, it was not often that he wrote off his matter satisfactorily at the first draft. There were, of course, enough occasions, as when he dashed off the review of the "Origin of Species" as "devil" for the regular *Times* reviewer, when the inward fire and the shortness of time conspired to produce a first-rate result; but in general his proof sheets were hard work for the printer. He would prune and recast until somehow it came right, and word and phrase truly represented his meaning and tallied with fact, so that,

as he used to say, he could stand cross-examination upon it. As time went on, he became ever more fastidious in giving exact expression to his thought, for he had a great love and respect for his native language.

In return he enriched current English with vigorous coinages of his own; the word Agnostic, for example; or phrases like "the ladder from the gutter to the University" or the definition of Comtism as "Catholicism minus Christianity," or of science as just "trained and organised common sense."

The same determined care in schooling himself turned him from a wretched lecturer into the best lecturer of his generation. A letter pointing out his faults of method and delivery he preserved carefully, labelling it "Good Advice."

With this clear, quick turn of thought and speech, his current talk, his stories, his humorous touches, were all delivered with a fine economy of words, abundant yet never clogged by excess. It was impossible, remarked a friend, to imagine him ever falling into "anecdoteage."

I have spoken of his drawing to amuse us as children; the artistic sense that formed his words passed also into his hand. His own father, following the odd maxim of his day that education should supply the gifts you have not instead of cultivating the gifts you have, gave him no lessons in drawing. With regular training and practice he might well have taken high rank among contemporary artists; as it was, we enjoyed the overflow of a skill rarely surpassed for drawing from memory on the blackboard anatomical details to illustrate his lectures. Various sketch-books too are filled with forcible sketches of places and figures seen on his travels and holiday excursions; and the official "*Voyage of the Rattlesnake*" is illustrated with reproductions of his drawings, though Macgillivray was careless enough to let the artist's signature appear as Hayley.

Good music he loved, though he played no instrument; and if in poetry he had no taste for formless jiggling nor what he dubbed "sensuous caterwauling," he knew his Shakespeare as he knew his Goethe, and responded to the splendours of Milton, the richness of Keats, the humanity of Browning, the felicity and scientific understanding of Tennyson. Late in life he took up Greek, first to make out what Aristotle really said about his dissection of the heart as against what his commentators alleged he said, then to read the New Testament in the original; and later the early philosophers, and finally Homer. German, which he had learnt as a boy and could read as easily as French and as fast as most people could read English, he used as a key to German literature and German science. Italian he had first hammered out with a dictionary on his tropical voyages for the sake of Dante, and of Latin he acquired enough to help him through early scientific works or even, when philosophic controversy demanded, theological treatises.

The mingling of clarity and strength, of depth and gaiety, which was characteristic both of his daily talk and his less frequent letters to us, was for children simply part of the accepted course of things. It was only later that its value could be realised or a comparative standard be reached by contact with others. I myself never had the fortune to attend one of his technical courses in biology; but the lectures at the London Institute which took final shape in the "Physiography" were vitalising to a child's mind, and left a lasting stimulus in quite a personal way, as if they had been part of the familiar talk we knew. As the years passed and one came to hear more lectures at the Royal Institution or elsewhere, to read his written essays, and to hear other talkers of repute, it became gradually clear how much more of what a famous headmaster called "real life" was to be got from his words than from those of others.

I possess, alas, all too few records of his actual talk, though some were set down, evening by evening, during my stay at Eastbourne in the last year of his life, and are reproduced in the "Life." His talk had the quality of his personal letters, raised to a higher degree of quickness and flexibility. He never pontificated, though there was solid matter enough dissolved in the bubbling freshness of his discourse, like Cleopatra's pearl in the cup, to give it strength and memorableness, and he varied it almost instinctively to suit the interests and the personality of his interlocutor. Argument as such was never part of his table-talk, nor did he indulge in monologue; there was the give and take that is implied in the word conversation, and a swift, humorous twist of the tongue would regularly make a keen riposte playful or divert the course of what in others threatened to develop into mere argumentation, a thing not to be tolerated at a dinner table. To every place its proper code. To the great lady who told one night at dinner how she had risen and left the village church when the parson began to read the Athanasian Creed, and demanded approval of the course she had taken, he replied, "My dear Lady X, I should as soon think of rising and leaving your table because I disapproved of one of the entrées."

Knowing his consistent habit in these matters, I promptly challenged the statement made in a recently published volume of reminiscences, that the author, then a young girl, had met my father at Jowett's table, and that he had then and there proceeded to indulge in a "blasphemous tirade." My challenge extracted the singular explanation that "blasphemous" merely meant "unorthodox." Some little time afterwards I was amused to learn from my sister that on his return from Oxford he had given an account of the visit, and particularly of that same vivacious young lady he had met; but, he added, what were modern manners coming to? She had attempted to open a theological

discussion at this unsuitable place and time, and he had promptly cut it short.

One word may be permitted as to his most intimate human relations and the atmosphere that a happy union created and preserved in the home. Happy are the children who have grown up in the shelter of such a union, the strength of which lay in mutual and self-sacrificing devotion, steadfast to meet the struggles, the trials, and the distractions of long and strenuous years:—years of waiting and hope deferred, years of realisation through struggle that must either make or break character; the fulfilment of it all in the home thought from abroad: "Nobody—children or any one else—can be to me what you are. Ulysses preferred his old woman

to immortality, and this absence has led me to see that he was as wise in that as in other things."

Those who have ever looked upon the "square, wise, swarthy face" of that "noticeable man" with keen, dark eyes and resolute orator's lips, a little saddened with the continued stress of ill-health, will not easily forget the expression of mingled power and sympathy which irradiated the rugged modelling of the features, the sublimation of a broad native humanity tried by adversity and struggle in the pursuit of noble ends. As Walter Besant wrote of his portrait, "There never was a face, I do believe, wiser, more kindly, more beautiful for wisdom and the kindliness of it, than this of Huxley."

### Huxley.

By Sir E. RAY LANKESTER, K.C.B., F.R.S.

IT is a wise thing to accept and continue the long-established custom of recalling at special intervals the life-stories and noble deeds of men who in the past have done great service to our race. The memory of them—unless so refreshed—readily passes from the thought of the many. Though treasured by a few it must be continually set forth anew by the observance of festivals or "holy days," in order that the knowledge of what those great men were and did may not fade but reach the present generation as a guiding light and a source of courage and heroic action. For this reason I am glad to be able to contribute a few lines to the present number of *NATURE*. We are celebrating the centenary of the birth of the great naturalist, philosopher, and teacher Huxley—the apostle of Darwin, the victorious opponent of traditional ignorance and superstition, the unflinching champion of veracity.

There are among us, I regret to recognise, not a few who whilst gladly benefiting by the increased respect for science and the freedom for the expression of scientific thought which was obtained for us by Huxley, yet shrink from carrying on his uncompromising warfare against ecclesiastical authority and official nescience. The urgent need at this moment for a re-birth of the vigilance and tenacity of Huxley is shown by the aggressive action of his discredited opponents who have recently procured the legislative exclusion of the teaching of the doctrine of evolution from the public schools and colleges of certain States of the American Union. It is also shown by the hatred of Darwinism which inspires the American politician W. J. Bryan. Whilst we are at present free in Great Britain from any declared sympathy with such intolerance, we have to deplore the fact that some men—whose words are widely disseminated by the public press—profess a belief in "the occult," the wonders of "telepathy," "clairvoyance," and "spiritualistic" manifestations. The credulity of the "occultists," their neglect of the experimental method of inquiry, and

their omission of exact veracious statement of the evidence for and against their conclusions, call for the attention of the younger generation since it is met with complacent indifference by most of their elders. Here there is work for them to do in the same spirit of knight-errantry as that which led Huxley in the early years of his career to attack the pretensions of clericalism and to gain an epoch-making victory for rational thought.

I desire to use this memorable occasion to urge younger men to acquaint themselves with the story of Huxley's career as told in the two volumes of his "Life and Letters" edited by his son Leonard, and by the collected edition of his essays, lectures, and addresses—in nine volumes, completed in 1894. It is in his letters and his essays and addresses on a very wide variety of topics that a reader may discover the character of the man—the convictions which directed his enterprise, and the personal charm, the humanity and gaiety of spirit which were never wanting even in his most strenuous intellectual work.

Huxley, after a course of medical studies in London, was appointed assistant surgeon in the Navy and joined the surveying ship *Rattlesnake* in 1847, when he was twenty-two years of age. He wrote and illustrated very numerous and valuable studies of the floating marine fauna now spoken of as "Plankton" which he encountered in southern seas. Some of these he sent home for publication, and brought a large number back with him at the end of 1850 when the *Rattlesnake* went out of commission. He was welcomed by Edward Forbes, Owen, Hooker, Carpenter and others who had in his absence formed a high opinion of the importance of his work and of the talents of the author. He was at once elected a fellow of the Royal Society, received the Royal Medal of the Society, and also was chosen as a member of its council.

Thus early Huxley's success was complete and exceptional as measured by the honours conferred upon him. But he failed to obtain any post or means of livelihood

beyond the small income he could make by scientific journalism and hack-work. This was a terrible trial for him, since he had become engaged to marry a lady with whose family he had formed a close friendship in Australia. It seemed to be his duty to abandon the doubtful prospect of a career in London as a man of science and to return to Australia to marry and settle down to a medical practice. He passed through a very bitter trial between 1851 and 1855. After a series of disappointments as to vacant professorships and such posts he writes to his sister: "I think of all my dreams and aspirations and of the path which I know lies before me if I can bide my time, and it seems a sin and a shameful thing to allow my resolve to be turned." Then again later he inclines to the other side and writes: "I can get honour in science but it does not pay. I begin to doubt if I have done wisely in giving vent to the cherished tendency towards science which has haunted me ever since my childhood." Then in 1853 he was encouraged to take a hopeful view. He writes: "I have become almost unable to exist without active intellectual excitement. I know that in this I find peace and rest such as I can attain in no other way. . . . My course in life is taken. I *will* make myself a name and a position as well as an income by some kind of pursuit connected with science, which is the thing for which Nature has fitted me if she ever has fitted any one for anything." "London," he declares, "is *the* place—the centre of the world."

At last, at the end of 1854, relief came. His dear friend Edward Forbes was appointed to the chair of natural history in Edinburgh, vacated by the death of Prof. Jamieson, and thereupon Huxley succeeded Forbes at Jermyn Street as naturalist to the Geological Survey and professor of natural history in the Government School of Mines, with an income which very soon was raised to 800*l.* a year. In July 1855 he was married to Miss Heathorn, who arrived from Australia with her parents. They had been engaged for eight years, and he had not seen her during the last five. Now at last he was able to settle down securely in London and to plan the future work of the busy life which lay before him. Heavy as were the tasks in lecturing, writing, in pure scientific investigation, and in advocacy of scientific doctrine which he gladly undertook, his life henceforth was a very happy one. Though from time to time he felt the strain of over-work, he could always recover his full strength by a tramp among the mountains of Wales or of Switzerland with the companionship of Tyndall, Hooker, or Lubbock. He had the immense satisfaction of knowing that he had chosen the right path, that his great natural gifts were exercised to the full, and were not only widely recognised and respected but were also effective in promoting the cause which he had at heart. It was in 1860 that, owing to his encounter with Wilberforce, Bishop of Oxford, at the meeting of the British Association, he became

known to the wider public as a fearless exponent of Darwin's theory. From this time onwards he added to the task of his regular professional teaching that of expounding in addresses and review-articles—which (at the first) he termed "lay-sermons"—the scientific and philosophical doctrines which in his judgment could be effectively so treated.

It is well to emphasise here, in conclusion, that the high value and influence of Huxley's more technical contributions to the science known as animal morphology are universally recognised. They are collected and reproduced in full in the four memorial volumes in the editing of which I was joined by Sir Michael Foster. They occupy about 2400 pages (royal octavo) and more than one hundred lithographic plates, many of quarto size. They show, as we stated in the preface to those volumes, that quite beyond and apart from the influence exerted by his popular writings, the progress of biology during the latter half of the nineteenth century was largely due to labours of his of which the general public knew nothing: and that he was in some respects the most original and the most fertile in discovery of all his fellow-workers in the same branch of science.

Were I to give an adequate account of my personal impressions of Huxley, this article would become a lengthy autobiography. Suffice it to say that from the time (1860) when I, then a schoolboy, took to him the chief treasure of my collection of fossils, namely, a mammalian jaw-bone from the Stonesfield slate which he himself laboriously developed from its matrix and intended to describe, I was fascinated by him and became his devoted disciple. I attended all his evening lectures and addresses, and followed with keenest pleasure his controversies. On his way home from Egypt in 1871 he came to Naples, where I had been established for some months studying the embryology of the Mollusca and the rich fauna of the bay, whilst my friend Dohrn was negotiating the foundation of the Zoological Station. Huxley, to my great delight, stayed some days at Naples, and I acted as his guide to the top of Vesuvius, to Pompeii and to the Phlegrean fields. Later I demonstrated for him in his first summer course in temporary quarters at South Kensington, and in the following year in his new laboratory in the College of Science. I was by his side when, without notes or printed paper, he delivered at the Belfast meeting of the British Association his address, lasting an hour and a half, on Descartes' theory that animals are automata. It was a wonderful effort and free from all hesitation or dislocation of words.

Others, no doubt, will be occupied at this moment in recalling the titles and significance of Huxley's published work. I must not venture on that congenial task. But I here submit two brief statements of an autobiographic character written by Huxley. The first was written in 1856 in his private journal on the night

when his son Noel was born—the son whom he lost four years later. It will be seen that the aspirations and intentions there expressed are not falsified by the retrospect embodied in the second extract, taken from his chapter of autobiography written some forty years later. They justify the motto adopted by him, "Tenax propositi."

*From Huxley's private journal, written in 1856.*

"In 1860 I may fairly look forward to 15 or 20 years' 'Meisterjahre,' and with the comprehensive views my training will have given me, I think it will be possible in that time to give a new and healthier direction to all Biological Science; to smite all humbugs, however big; to give a nobler tone to science; to set an example of abstinence from petty personal controversies and of toleration for everything but lying; to be indifferent as to whether work is recognised as mine or not, so long as it is done."

*From a chapter entitled "Autobiography" written by Huxley in 1893 and published in the volume of essays called "Methods and Results," pp. 16 and 17.*

"Men are said to be partial judges of themselves. Young men may be; I doubt if old men are. Life

seems terribly foreshortened as they look back, and the mountain they set themselves to climb in youth turns out to be a mere spur of immeasurably higher ranges when, with failing breath, they reach the top. But if I may speak of the objects I have had more or less definitely in view since I began the ascent of my hillock, they are briefly these: To promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life to the best of my ability, in the conviction which has grown with my growth and strengthened with my strength, that there is no alleviation for the sufferings of mankind except veracity of thought and of action, and the resolute facing of the world as it is when the garment of make-believe by which pious hands have hidden its uglier features is stripped off.

"It is with this intent that I have subordinated any reasonable, or unreasonable, ambition for scientific fame which I may have permitted myself to entertain to other ends; to the popularisation of science; to the development and organisation of scientific education; to the endless series of battles and skirmishes over evolution; and to untiring opposition to that ecclesiastical spirit, that clericalism, which in England, as everywhere else, and to whatever denomination it may belong, is the deadly enemy of science."

### Thomas Henry Huxley.<sup>1</sup>

By Prof. E. B. POULTON, F.R.S.

WHEN I was invited to deliver the Huxley Lecture, and I need not say how great a distinction I felt the invitation to be, I thought how much better it would have been if the address could be delivered by one with much longer and more intimate associations with the great man whose memory we have met to honour. My mind at once turned to my friend Sir Ray Lankester, who, when Huxley died, could look back over nearly forty years and write: "There has been no man or woman whom I have met on my journey through life, whom I have loved and regarded as I have him, and I feel that the world has shrunk and become a poor thing, now that his splendid spirit and delightful presence are gone from it. Ever since I was a little boy he has been my ideal and hero." I would that he could be here to tell us of his abiding memories; but as this cannot be, he has most kindly yielded to the wish of an old friend and has sent a message:—

"I believe that no one of Huxley's scientific friends now living knew him so well or watched him with so keen an affection as I did, and I feel that the centenary of his birth is not so much an occasion for dwelling on his scientific work as of thinking and speaking of his personal characteristics and testifying to his living quality and charm.

"Our main duty towards those who have never seen him, the youth of this day—cut off from traditional knowledge by the slaughter and disorganisation of the Great War—is to urge them to make up for their loss by their own effort, to read and discuss Huxley's writings for themselves, not only his published researches but also the delightful essays, full of wit and wisdom and an actual gospel of freedom for thought and loyalty to truth. Then, too, we have the record of his strenuous life preserved for ever in his vivid letters—his heroic adhesion to a career in science when fate seemed to forbid—his success after long years of disappointment—his friendships with Edward Forbes, Hooker, Huxley, Tyndall and Darwin. These men were also my father's friends, and, as a boy, from 1859 onwards, I became Huxley's devoted admirer and disciple, attending all his lectures in my own time out of school, following his contests with Owen and other opponents of Darwin, and encouraged by his help and personal kindness to share, however humbly, in the almost daily excitement of his zoological discoveries and his brilliant encounters with doughty knights of the pen."

The thoughts which Sir Ray Lankester has expressed with much greater authority were also my own—that to-day we should try to recall a great personality, the man himself, his powers and their growth, his attitude towards life, finding in the attempt that the heights he attained were only reached by resolute effort and

<sup>1</sup> From the Centenary Lecture delivered at the Royal College of Science (Imperial College of Science and Technology), South Kensington, on May 4.

undaunted determination. Thus Huxley will become to the young student, not some far-off impossible ideal, but a great example and encouragement.

Huxley was the youngest of the five men who, more than all others, gave life to the ancient conception of evolution, and made possible the chief intellectual inspiration of the modern world. Wallace was two years older,

Spencer five, Hooker eight, and Darwin sixteen. He tells us in his brief autobiography that he inherited from his father the faculty for drawing, a hot temper, and "that amount of tenacity of purpose which unfriendly observers sometimes call obstinacy"; from his mother rapidity of thought. The high development of this last quality was referred to by Darwin in his own autobiography: "I have no great quickness of apprehension or wit which is so remarkable in some clever men, for instance, Huxley."

A keen sense of

humour was invaluable in his varied dealings with men. Think of his words of caution to one who sought a post in which there would be numberless "little vanities and rivalries to smooth over and conciliate," a post which, of necessity, required the utmost forbearance: "Now you do *not* 'suffer fools gladly'; on the contrary, you 'gladly make fools suffer.'" The humour here emphasises but at the same time softens the advice and renders it acceptable.

Huxley described himself as "almost a fanatic for

the sanctity of truth." Referring to some adverse opinion, he wrote to his wife that he did not know what was meant by "the disputed reputation" unless it was "a reputation for getting into disputes," continuing: "To say truth I am not greatly concerned about any reputation except that of being entirely honest and straightforward, and that reputation I think and hope I have."

He once said that it was only when trying to comfort

a friend in trouble that he was sometimes tempted to deviate from the strict truth. His deeply sympathetic nature is also revealed in words spoken to his son in 1895, a few months before he died: "It is one of the most saddening things in life that, try as we may, we can never be certain of making people happy, whereas we can almost always be certain of making them unhappy."

Huxley's differences with his friends — sometimes sharp differences in opinions conscientiously held, where there could be no yielding on either side — brought no bitterness and

no estrangement. The issue was treated with the utmost candour, and, with regard to it, there was the fullest recognition of divergence, but at the same time there existed on both sides a fixed determination that the difference should never be permitted to spread beyond the issue and weaken any of the innumerable ties by which friend is bound to friend. To read his correspondence with those from whom he differed is an education in the preservation of friendship.



From a wet-plate photograph taken about the year 1877 at Kimmerghame, by Mr. A. A. Campbell Swinton, F.R.S.

Huxley, like Darwin and Hooker, owed much to the years with the Navy, when he was thrown upon his own resources in attempting to solve the exciting zoological problems which were always confronting him. How fully he acknowledged the value of this experience is revealed in a letter to Hooker on November 15, 1888, when he received the Copley Medal of the Royal Society the year after it had been awarded to his friend :

"Who ever heard of two biologists getting it one after another? . . . It is getting on for forty years since we were first 'acquaint,' and considering with what a very considerable dose of tenacity, vivacity, and that glorious firmness (which the beasts who don't like us call obstinacy) we are both endowed, the fact that we have never had the shadow of a shade of a quarrel is more to our credit than being ex-Presidents and Copley medallists.

"But we have had a masonic bond in both being well salted in early life. I have always felt I owed a great deal to my acquaintance with the realities of things gained [in] the old *Rattlesnake*."

It must be remembered, however, that he suffered a good deal of disappointment in the quiet contempt for scientific pursuits shown by the officers, and in the long periods which passed before he received any intelligence of the papers on his researches which he had sent home.

Far greater trials awaited him when he returned to England in 1850, and entered upon four solitary years of despondency and vain attempts to obtain a position which would enable him to marry without giving up the work he loved best. A few weeks after his return he wrote to his favourite sister, who had settled in America, telling her of his parting with his future wife, to whom he had become engaged at Sydney in 1847. A few words reveal the solitude he endured: "You know I love but few—in the real meaning of the word, perhaps, but two—she and you. And now she is away and you are away."

An even greater trial was the insistent doubt whether he was doing right in continuing an engagement with so poor a prospect of marriage, and whether he ought not to enter a profession and in so doing starve what he knew to be the best that was in him. Then there was the barrier of distance, a letter requiring three or four, sometimes even six months, to reach Sydney; but in spite of all the difficulties, it was the correspondence with his future wife and his sister which finally confirmed him in the determination to keep to the work which called forth his highest powers.

He became an F.R.S. in 1851, when he was twenty-six. There were thirty-eight candidates, and the number of elections was fifteen, as at the present day. In the following year he was awarded the Royal Medal, but his pleasure at this recognition could not last long in a time of deep disappointment and bitterness.

"The honours of men I value so far as they are evidences of power," he wrote a few days after the award was made known, "but with the cynical mistrust of their judgment and my own worthiness, which always haunts me, I put very little faith in them. Their praise makes me sneer inwardly. God forgive me if I do them any great wrong."

The fierce and bitter rivalries of that time were a further trial, from which we have been happily freed by an ever-increasing specialism which leads the scientific worker to seek help from another and give help to him rather than attempt to enter a strange land.

Huxley was, at this period of his life, an unsuccessful candidate for biological chairs at Toronto, Aberdeen, Cork, and King's College, London. While still hoping that he might obtain the last of these he wrote to his sister, in April 1853, words which reveal the despair that was coming over him :

"In truth I am often very weary. The longer one lives the more the ideal and the purpose vanishes out of one's life, and I begin to doubt whether I have done wisely in giving vent to the cherished tendency towards Science which has haunted me ever since my childhood. . . . I think it is very likely that if this King's College business goes against me, I may give up the farce altogether. . . ."

Later in the same year a letter from Sydney brought him comfort. "I wish to Heaven it had reached me six months ago," he wrote, "it would have saved me a world of pain and error." Thus strengthened he kept firm and did not again lose heart, until at length, in July 1854, the tide turned and he was appointed to two lectureships at the School of Mines, held by Edward Forbes, who had just been called to an Edinburgh chair. The double post was paid 200*l.* a year, and yet such was the encouragement given to science in those days that he wrote on July 30: "I am chief of my own department, and my position is considered a very good one—as good as anything of its kind in London." However, he had not long to wait before other work was offered to him, so that he was able to marry in the following year.

Huxley is well known to have been one of our finest and most powerful speakers, but he gained this success by determination and by practice. I have heard Prof. Rolleston refer to Huxley as a great example of the results which may be achieved by one who is not fluent by nature. A young man who realises the value of the weapon but doubts his own capacity and nerve may well take courage when he hears Huxley's account of his own feelings as he began his first lecture at the Royal Institution in April 1852: "I can now quite understand what it is to be going to be hanged, and

nothing but the necessity of the case prevented me from running away."

What he became is well shown by the words of a would-be critic who attempted to make out that Huxley was no great speaker: "All he did was to set some interesting theory unadorned before his audience, when such success as he attained was due to the compelling nature of the subject itself." This surely was the highest compliment that could be paid to a man as a speaker—that he thought of his subject rather than of himself; and it is here that natural fluency becomes so great a danger, a temptation to the speaker to attitudinise upon his subject rather than to display it, to forget that its "compelling nature" can only be revealed by serious effort in searching analysis and clear description.

Public speaking remained an effort to the end of his life. Just as the company was about to enter the dining-hall for the Anniversary dinner of the Royal Society in 1892, I happened to hear Sir Michael Foster ask Huxley to help the officers out of a difficulty by proposing the toast of the medallists, in the sudden and unavoidable absence of the speaker named on the menu. He promised to fill the gap, but I am afraid that as a result he did not enjoy his dinner, for from time to time he sat with closed eyes, evidently thinking deeply about his speech. Nevertheless he began by making a trenchant reply to a previous speech, and, for his main theme, gave a brief but finished account of the history of the medals and the work of the medallists, concluding with a charming defence of the Society for the first two awards of the Darwin Medal, intended primarily for young men:

"It lay in the eternal fitness of things that Wallace and Hooker should receive the Darwin Medal; and that these old young-men should give it a heightened value for the young young-men to whom it would hereafter pass." But before this, its value was to be still further heightened, for the next award was to a third "old young-man," and Huxley's last public speech was a reply for the medallists when he received the Darwin Medal in 1894.

The clear and beautiful style of Huxley's writing was also an outcome of great effort. "I have a great love and respect for my native tongue," he wrote in 1891, "and take great pains to use it properly. Sometimes I write essays half-a-dozen times before I can get them into the proper shape . . ."; and, in 1887: "When I get to a certain point of tinkering my phrases I have to put them aside for a day or two."

Here, as with his public speaking, we may hope that his great example will encourage young men of science, leading them to practise severe self-criticism and never to be content with careless writing. There is reason to

fear that such efforts are quite as necessary now as in 1894, when Huxley, referring to his speech at the twenty-fifth anniversary of NATURE, wrote: "I scolded the young fellows pretty sharply for their slovenly writing." In another respect we may hope that Huxley's example will be followed. It should never be forgotten that he found constant delight in the great writers of English; he was not only a great man of science, he "warmed both hands before the fire of life."

This is not the occasion for dwelling on Huxley's zoological or palæontological discoveries. Dr. Chalmers Mitchell has told us that when he came to study the classical monograph on the Hydrozoa, he at first felt some disappointment. It was all so familiar, rather like the Hamlet which, read for the first time, was found to be "so full of quotations." So also with the work upon birds and his anatomical researches generally: as Dr. Mitchell well says, "Huxley's work was essentially living and stimulating, and too often it has become lost to sight simply because of the vast superstructures of new facts to which it gave rise." For this reason the late Mr. G. H. Verrall used to say that "the best monograph is the one soonest out-of-date"—a fruitful parent supplanted by its own offspring.

The *essential* duty of a university, as Huxley believed it to be, is set forth in a sentence, written in 1892:

"The modern world knows that the only source of real knowledge lies in the application of scientific methods of enquiry to the ascertainment of the facts of existence; that the ascertainable is infinitely greater than the ascertained, and that the chief business of the teacher is not so much to make scholars as to train pioneers."

It is interesting to observe how nearly the scientific and the literary judgments may agree. I have heard the following opinion expressed with characteristic emphasis by the late Prof. York Powell:

"Many people think that a university must consist of professors, tutors, lecturers, colleges, delegacies, committees and all kinds of administrative offices, but in reality only two things are *essential*—a library and a printing-press, and of course for science-men, laboratories and a museum."

In the introduction to the volumes of Huxley's collected scientific papers, the editors, Sir Michael Foster and Sir Ray Lankester, express the fear that his classical discoveries may be forgotten. At that time it seemed that his collected essays on more general subjects would always be widely read; but the great barrier of the War has intervened, and it is now, I am afraid, necessary to remind young men, as Sir Ray Lankester has done, of all that they will lose by the neglect of these volumes.

Much has been written during the past few weeks on

the need for popular reprints of books with sound views on economic subjects, and various works have been suggested as suitable for the purpose. So far as I am aware, no mention has been made of Huxley's essays on these questions, and yet how much misery would have been prevented if the wise advice he has given had been followed. No doubt can be thrown upon his love for the people and desire to better their condition. "If I am to be remembered at all," he wrote in 1880, "I would rather it should be as 'a man who did his best to help the people' than by any other title." He put his best work into the courses for working-men, and refused to consider the proposals to give them up when it was suggested that there were now many institutes and colleges open to such students. He still wished to give them something they could not get elsewhere, and working-men gratefully recognised the work that he did for them and loved him for it. If his words were made readily accessible, there is hope that they would find listeners among the men who would suffer most from the delusions and chimæras which some among them appear to find so attractive. Here are his conclusions to the discussion of certain important economic questions of his day and ours :

"Assuredly, if I believed that any of the schemes hitherto proposed for bringing about social amelioration were likely to attain their end, I should think what remains to me of life well spent in furthering it. But my interest in these questions did not begin the day before yesterday ; and, whether right or wrong, it is no hasty conclusion of mine that we have small chance of doing rightly in this matter (or indeed in any other) unless we think rightly. Further, that we shall never think rightly in politics until we have cleared our minds of delusions, and more especially of the philosophical delusions which, as I have endeavoured to show, have infested political thought for centuries."

"... Seeing how great and manifold are the inevitable sufferings of men ; how profoundly important it is that all should give their best will and devote their best intelligence to the alleviation of those sufferings which can be diminished, by seeking out, and, as far as lies within human power, removing their causes ; it is surely lamentable that they should be drawn away by speculative chimæras from the attempt to find that narrow path which for nations, as for individual men, is the sole road to permanent well-being."

The great event of Huxley's career was his defence of Darwin, leading on to something much wider and deeper, the defence of freedom for thought. A large part of the volumes of essays is concerned directly or indirectly with this subject. The necessity for defence, both special and general, was amusingly explained by him in his last public utterance when he returned thanks for the Royal Society medallists on November 30, 1894. He said that, when the award of the Darwin

Medal was announced, "the ingrained instincts of an old official" led him at once to consider "how can my Government be justified ?" He had no such claims, he said, as his two predecessors, and had begun to despair of providing an answer to the critics of the Royal Society, when there occurred to him "that famous and comfortable line . . . 'They also serve who only stand and wait.'"

"I am bound to confess," to continue in his own words, "that the standing and waiting, so far as I am concerned, . . . has been of a somewhat peculiar character. I can only explain it, if you will permit me to narrate a story which came to me in my old nautical days, and which, I believe, has just as much foundation as a good deal of other information which I derived at the same period from the same source. There was a merchant ship in which a member of the Society of Friends had taken passage, and that ship was attacked by a pirate, and the captain thereupon put into the hands of the member of the Society of Friends a pike, and desired him to take part in the subsequent action, to which, as you may imagine, the reply was that he would do nothing of the kind ; but he said that he had no objection to stand and wait at the gangway. He did stand and wait with the pike in his hands, and when the pirates mounted and showed themselves coming on board he thrust his pike with the sharp end forward into the persons who were mounting, and he said, 'Friend, keep on board thine own ship.' It is in that sense that I venture to interpret the principle of standing and waiting to which I referred. I was convinced as firmly as I have ever been convinced of anything in my life, that the *Origin of Species* was a ship laden with a cargo of rich value, and which, if she were permitted to pursue her course, would reach a veritable scientific Golconda, and I thought it my duty, however naturally averse I might be to fighting, to bid those who would disturb her beneficent operations to keep on board their own ship."

Out of this struggle came the recognition of the fact that something much more important than Darwinism had been challenged, nothing less indeed than the validity of scientific thought. "The welfare of mankind," Sir Michael Foster has said, "was, in his eyes, indissolubly bound up with the advance, the steady, nay, the rapid advance of natural knowledge. Any hindrance to that advance was, to his mind, a wrong to mankind. What hindrance could be more hurtful than the contention that natural knowledge was not master of its own domain, but must bow its head and keep silence when even in its own field it came into conflict with the master of another land ? The call to strive for the doing away of that hindrance rang loud in Huxley's ears." His answer to that call has had the great result that "scientific ways of thinking, which are even more important than scientific discoveries," may, at least in this country, be followed peacefully, while those who might have been inclined to raise a barrier are now wise enough to "keep on board their own ship."

## Plant Biology in the 'Seventies.

By Sir W. T. THISELTON-DYER, K.C.M.G., C.I.E.

THE Editor's request for some account of my relation with Huxley "in the organisation of the teaching of botany at South Kensington" and for reminiscences of him requires some autobiography to explain how it arose.

I was London-bred and educated in London day schools. My parents lived in Berkeley Street, where my father practised as a physician. A noisy rookery woke me in the morning to see the sun on the Crystal Palace and Buckingham Palace in mist. St. Peter's in Eaton Square was my first school, a classical temple long since demolished, balancing the church at the other end; it had produced a senior wrangler, who was exhibited on Speech Day, and Sir Charles Dilke was a school-fellow. I passed on to King's College School in the classical side.

Summer holidays were spent at Bury Street near Edmonton, at the house of my maternal grandfather, Thomas Firminger, LL.D., who had been "sole assistant Astronomer" with Dr. Maskelyne at Greenwich (1799-1808). I remember his telling me that, narrowly escaping being run over in Fleet Street, his only anxiety at the moment was the lunar observation that night. There was a scientific atmosphere at Bury Street; boyish curiosity was stimulated by various pieces of apparatus the purpose of which was only gradually revealed. There was a primitive electrical machine which we induced my grandfather to put into action with striking results. The culminating excitement was an occultation of Jupiter watched through a large telescope. I got further nutriment from Joyce's scientific dialogues.

My mother was a keen field botanist; during the holidays she initiated me in the Linnæan system and the determination of the plants we collected—she insisted on securing radical leaves!—in Sir William Hooker's "British Flora." I still possess the well-thumbed volume. Later, at school, I ran up against a school-fellow with a vasculum. I said, "You are a botanist?" he replied, "I am," and then and there we swore eternal friendship. This was Henry Trimen, who died director of the Peradeniya Botanic Garden.

We soon agreed that mere collecting was not a sufficient end in itself, and while still schoolboys we commenced a botanical survey of Middlesex; it was published in 1869. We did not think at the time that we should take part later in a larger survey of the Empire. Our smaller enterprise afforded more than one illustration of the scientific outcome of such work. The Thames is the southern boundary of the county;

we found on its east side that there were estuarine plants brought by the tide, while on the west were calciphilous plants brought by winter floods.

I found a never-failing resource on half-holidays, when botanical field-work was out of season, in the Geological Museum which was near at hand in Jermyn Street. I doubt if anything of its contents escaped me, from the vast geological map on the ground floor to the solar system on the topmost gallery. But a deeper attraction was the evening lectures to working men delivered by the professors of the School of Mines. Perhaps my frequenting the museum allowed me admission without challenge.

It must have been in his memorable course in 1862 that I first saw Huxley. His 1857 portrait recalls to me his alert expression, the twinkle of the eye, firm mouth, and that general aspect which he called Iberian. His choice of words was always apt, and their delivery pleasant to the ear. The lectures themselves were carefully prepared; they were, fortunately, published, and remain a classic. As is well known, Huxley had to rely in Jermyn Street on oral teaching alone, with seldom anything to support it but what Flower described as "his great facility for bold and dashing sketching." I can recall only one detail of actual demonstration. A plate appeared on the lecture table with an oyster and a knife. Having explained that the oyster was kept closed by muscular action, he remarked, "If the cook is a person of any judgment at all, she will insert the knife here." He did so, and the valves fell apart. The quizzical expression and its rhythm I knew afterwards to be authentic Huxley.

It was in these lectures that Huxley, with his invariable honesty, told the working men that though the Darwinian hypothesis held the field, "its logical foundation was insecure," and he never shook himself from this position. He came to look upon the defect as of no importance in view of the impregnable basis supplied by palæontology to evolution.

The following year I went to Oxford and studied mathematics with Henry Smith and chemistry with Brodie. I took my degree with honours in both. When my father died in 1868, the Berkeley Street home was broken up. I had to find a livelihood; teaching seemed the only choice and botany my vocation. It had been decided at Oxford that when there was a vacancy in the dormant chair I would be appointed. This had occurred in 1867; but the technical disqualification of not having reached M.A. standing ruled me out, and the chair went to my friend Lawson, a Cambridge man.

In 1870 I was appointed professor of botany in the Royal College of Science for Ireland, Dublin, under the Science and Art Department. The emolument was little more than nominal, but the teacher was fortunate in being unfettered by any curriculum. According to the late Prof. Bayley Balfour, "the study of Botany as a science has been dependent on Medicine, and its aim to give the practitioner a correct knowledge of the plants which were the source of drugs." So limited, it was a compulsory part of medical training with its sequel *materia medica*. Huxley thought that this had become a mischievous encumbrance to study constantly more exacting; the practitioner would use drugs, but their manufacture no more concerned him than the metallurgy of his instruments a surgeon.

The ninth edition of the "Encyclopædia Britannica" contains *the* article on botany by the elder Balfour; it may be not unfairly regarded as representing the current view of the scope and limits of botanical science in 1876. It covers more than eighty pages in double columns, but does not profess to treat more than the "Structure and Morphology of Plants," that is, little more than flowering plants. It may seem paradoxical, but in any wide sense it does not treat of botany at all. Balfour simply tumbled into the Encyclopædia his class text-book for Edinburgh medical students; it is, in fact, no more than an illustrated enumeration of the terms devised by Linnæus for descriptive botany. These, especially when clothed in Latin, are in cosmopolitan use. When exhaustively applied to a particular plant it is said that a competent artist could build up its portrait without seeing it. It is difficult to imagine anything more uninspiring than a terminological diet. Balfour made it tolerable by a system of excursions, which invested it with some reality. The greater part of Scotland was traversed; students were introduced to what is now known as "ecology." Balfour could and did look at plants in relation to the conditions of growth; his students got to "know their plants," which Sir Joseph Hooker thought the great desideratum.

In 1871 I planned and delivered a course in Dublin covering the whole vegetable kingdom; it was a new departure in botanical teaching. But, as with Huxley in Jermyn Street, I had no laboratory or even a private room to myself. No practical work by the students or even demonstrations to them were possible.

My duties in Dublin only occupied the first half of the year and afterwards left me free. I returned to London at the end of July (1871) and reported myself to Capt. Donnelly, the Inspector for science at South Kensington. He introduced me to Huxley, who had organised in temporary accommodation a six weeks' course for teachers, in which he had Michael Foster,

Lankester, and Rutherford as assistants. I spent a day in watching the proceedings. Such courses for teachers were vacation work independent of the systematic teaching covering the animal kingdom for ordinary students, which Huxley continued on the same lines as in Jermyn Street; but there was the all-important difference that he was now able to supplement oral teaching by practical dissection and demonstration. In the following year he inaugurated his new laboratories with a summer class, in which the now well-known course of "Elementary Biology" was given for the first time, with the same demonstrators, "assisted by H. N. Martin." It is not to be wondered at that the double-tide of lecturing and the strain of organisation in the transfer to South Kensington left Huxley "very shaky in health." It had been arranged, therefore, that he should have a holiday abroad, and that in 1873 "I should take his place and lecture on botany" with "the application of the same system to botanical teaching."

Huxley's first love had been botany; it was the subject of his first prize. He attended Lindley's lectures at the Chelsea Botanic Gardens and won another, a gold medal, in a competition from the Society of Apothecaries. He got no comfort from Schleiden's "Principles of Scientific Botany" (1847) (nor did I), but explored with better results the *Annales des sciences naturelles* at the British Museum. Later, we both drank at the same spring.

I drew my own inspiration from the fourth edition of William Carpenter's "Principles of Comparative Physiology" (1854). This contained incidentally the only accounts in English for the next quarter of a century of the most striking advances in our knowledge of the life-histories of plants. Carpenter, as he told me, saw Count Lesczyc-Suminski when he brought to London the fern-prothallus (1848) which the Ray Society scouted. It had been better advised when it published in 1862 a translation of Hofmeister's "Higher Cryptogamia" (1851). Of this immortal work Sachs says: "When Darwin's theory was given to the world eight years after, the relations of affinity between the great divisions of the vegetable kingdom were so well established and so patent, that the theory of descent had only to accept what genetic morphology had actually brought to view."

Huxley wrote of Carpenter with affection: "I was a very young man, almost friendless in the scientific world, when I returned to England in 1850. I made Carpenter's acquaintance in 1851, and was able to give him some information which he found useful for a new edition (the fourth) of the 'Principles of Comparative Physiology.' From that time he remained a friend who did me many a good turn."

I had accepted Sir Joseph Hooker's invitation to assist him by sub-editing his "Flora of British India." Teaching at South Kensington continued temporarily my attachment to the Science and Art Department, but was scarcely compatible with work for it in Dublin, which I therefore gave up in 1872.

About this time the ninth edition of the "Encyclopædia Britannica" was started under the editorship of Prof. Baynes. Huxley and Clerk Maxwell were helping him "in attempting to cover the ground of modern science." Huxley had made good progress in getting the animal kingdom well in hand, and was keen to get the vegetable kingdom treated on similar lines, but . . . ! Towards the end of the year I received a letter from him inviting me to meet Baynes at his house, but he could only make an appointment for 11 o'clock on a wintry night. Huxley opened the door himself, led the way to his study, and put on a kettle to boil. I was introduced to Baynes, who at once started a discussion of "free will." Huxley would not have it. He told Baynes that if we could project ourselves back into the cosmic vapour and then look forward we would be seen drinking our gin and water. Baynes said no more. As to the vegetable kingdom, Huxley got no comfort. Nothing could be done until the incubus of Balfour's preposterous article was got rid of, and it appeared that a binding contract with the publishers made this impossible. No more could be arranged than that I was to join Huxley in writing the preliminary article on biology. This was done, and published in 1875. In 1902 the tenth edition gave the vegetable kingdom a worthier treatment. Under Dr. Scott as botanical editor, it was illustrated and illuminated by a series of articles more up-to-date for the most part than anything accessible at the time.

The 1873 course commenced on June 24 and lasted for six weeks. The lectures presented no difficulty, as the ground had already been gone over in Dublin. The plan was that adopted by Huxley: a lecture at 10 o'clock and then an adjournment to the laboratory, where each student was provided with a place, microscope, and necessary instrumental appliances. The work continued from 11 to 1 P.M. and from 2 till 4. It was expected that, with the assistance of the lecturer and his assistants, the students would then have succeeded in verifying every material statement made in the lecture.

I was confronted with the difficulty that we had no tradition to follow or previous experience to guide us. The whole business was one of sheer adventure. I secured the help of Prof. Lawson from Oxford, and also took over Jeffrey Parker, Huxley's assistant. Lawson and I took lodgings together at Gunnersbury, so as to be within easy reach of Kew. For an account

of how we worked and with what measure of success I must make use of a letter which I wrote to Prof. Reynolds Green while the details were fresh in my memory. It was not published until after his death in 1914.

"The difficulties we had to encounter were enormous. The first was to keep up a continuous supply of material; but we had Kew to draw upon, and a great number of helpful friends. Archer in Dublin sent us fresh-water Algæ (including *Closterium*, with its internal display of Brownian motion); a banker at Margate, marine Algæ; Ransome of Nottingham and De Bary (through Lankester), *Æthalion*; H. C. Watson, *Pilularia*, etc. The worst difficulty was to make sure of our own ground; Lawson and I were generally up half the night rehearsing the demonstration for the following day. However, we soon worked the class up to a pitch of enthusiasm, and this helped enormously. I was perfectly frank in explaining our own inexperience and enlisting its help. The more expert men often had good luck in 'getting things out.' The upshot was that we succeeded in showing shoals of things that had never been seen in England before. News of what was going on soon got about, and though we were flattered, we were a good deal bothered by visitors. No one had ever seen in this country an active plasmodium of a Myxomycete, and Klein asked to be telegraphed for when it began to work. W. Kitchen Parker spent most of his time in the laboratory. Sir Edward Poynter came to see vegetable spermatozoids, and we gratified him with those of *Chara* under a one-twelfth immersion objective. Gymnosperms gave us most trouble. I was very keen to demonstrate what Hofmeister had done, and to trace the outcome and fate of the megaspore from the Fern upwards. It would have seemed hopeless if Casimir de Candolle had not come to England after working with Strasburger, and brought a number of preparations with him. He showed me that the difficulties were not insuperable. This was before the days of microtomes, or even embedding. . . . However, the ground of the new teaching was broken once for all."

I was fairly brain-tired at the end. But three weeks with the 1st Oxfordshire Light Infantry—the University Corps—at the Dartmoor manœuvres remedied that. The occasion was memorable, as this was the first time that volunteers had been brigaded with regular troops. I went back to the ranks, and I am afraid my energetic sergeant, now the venerable Provost of Queen's College, found me rather slack.

Huxley and Donnelly were more than satisfied with our experiment; the former asked me to take charge of the practical work of his biology class in the following year. It had a surprise visit from the President of the Council (the Duke of Richmond) and the Education Minister (Lord Sandon).

In 1875 I was asked to repeat my own course in a more leisurely eight weeks, with Vines as demonstrator. I gave it again the following year, when I willingly

complied with Donnelly's wish that women teachers should be included, and for the first time.

In 1875 Disraeli, with whom I never had any acquaintance or communication, appointed me assistant director of Kew. I should have preferred staying at South Kensington if any hope of a permanent appointment could have been held out. But this appeared to be impossible. However, I was asked (and permitted) to give a final course in 1880, consisting only of the lectures.

Having put my hand to the Kew plough, I felt in honour bound not to draw back. But this disposed of my teaching ambition. If my friend Prof. Oliver is right in giving me credit for establishing the "New Botany," it was the co-operation and sympathy of Huxley that made it possible, and that is a memory to be proud of.

I think I may claim that my 1871 Dublin syllabus was the first rough sketch. I will quote the first sentence:

"Botany, the study of Plants; correlative to Zoology, the study of Animals. The two conjointly form Biology, the study of Living things."

In 1875 Huxley wrote in the preface of his "Practical Instruction in Elementary Biology":

"Twenty years ago, I arrived at the conviction that the study of living bodies is really one discipline, which is divided into Zoology and Botany simply as a matter of convenience."

Twenty years before finds Huxley in touch with William Carpenter and the "Principles of Comparative Physiology." This was the germ which eventually fruited in the laboratories at South Kensington inaugurated in 1872.

And in Dublin half a century later (1922) Dr. Dixon, the University professor, has presented his students with what I can only describe as a consummate and beautiful picture of detailed "Practical Plant Biology."

### Teaching of Biological Science.

By Prof. F. O. BOWER, F.R.S.

THE influence of Prof. Huxley has moulded education in many ways. Others will tell of his activities as a zoologist, as an administrator, and member of many Royal Commissions; and as an essayist and writer of text-books that profoundly affected the schools at the time when scientific subjects were first entering into competition with the strict discipline of the classics. But now, half a century after the event, it may not be so readily remembered that it is to Huxley's initiative that the current method of laboratory teaching of the biological sciences in universities and colleges is mainly due.

Up to the middle of the nineteenth century authoritative statement by the teacher, rather than personal observation, was the source of knowledge for the ordinary student of the biological sciences. It is true that occasional microscopic demonstration had been early initiated in Edinburgh by the elder Balfour. We read also of Hofmeister guiding the laboratory work of a band of enthusiasts in Tübingen; and elsewhere no doubt sporadic work was being done in biological laboratories. But it is undoubtedly to Huxley that we owe the initiation of that systematic laboratory training which has now become general. He laid special stress upon personal observation at first-hand as the leading feature of biological study, even for elementary students. He did not abolish the lecture-room, but he linked it with the laboratory, so that the student, duly primed with a vivid description of what

others had seen, passed to the laboratory to see, confirm, or criticise for himself. Those who have grown up under this newer method will with difficulty realise the revulsion thus brought about. Its effect was at a single stroke to convert each student into a potential investigator. On the other hand, the new method would react inevitably upon the teacher, boomerang-fashion. Knowing that any or all of his students might form an independent estimate of the matter in hand, he must not only be accurate in fact, but also be ready for discussion. Every laboratory class became at once a potential board of examination of the demonstrating staff.

I had not the advantage of seeing for myself the first experimental trials of the new method. We may imagine what kind of courses they must have been under the direct management of Huxley himself, assisted by Burdon-Sanderson, Martin, Thiselton-Dyer, and Ray Lankester. The course for beginners was soon crystallised into the well-known volume on "Elementary Biology," by Huxley and Martin. Here a number of carefully selected plants and animals, starting from the simplest and progressing to more complex forms, were subjected to detailed structural analysis, together with some simple physiological experiments. The text described each step of preparation, and the results to be expected. Thus the method became stereotyped. Where the book fell into less expert hands, and its spirit filtered through

less potent minds, the results were naturally less satisfactory; but this fact does not discount the excellence of the method.

Very soon more detailed courses were devised respectively on animals and plants separately. Those on plants were conducted by Thiselton-Dyer, and I demonstrated to some of the earliest of these, with Vines, Marshall Ward, and Alexander MacNab as colleagues. The method was the same, and the courses were held in Huxley's laboratory. But he himself was only seen at intervals, and took no part in the botanical work. About this time Vines had tentatively spread the system to Cambridge, where a small band of enthusiasts gathered around him in a room lent for the purpose in the physiological department by Sir Michael Foster: among these I was one of the earliest adherents.

Having this experience in hand of the practical working of the new method, the transition was not difficult from demonstrator to lecturer, and in 1882 I found myself appointed to conduct the regular courses in botany for teachers in training which were then initiated, in place of the occasional courses for selected school-teachers in the summer. The elementary course consisted of lectures and laboratory work, for which I was personally responsible. Up to this time I had only seen Huxley occasionally, and never at near hand. I was still inclined to visualise him as he appeared in photographs of the period of the Oxford Meeting of the British Association: as the protagonist of Darwinism, with aspect as incisive as his speech, and arrayed in the dress of the period. In coming into close official relation with Huxley I found him to be a man of medium height, with a well-knit figure, rather greyish in complexion, clean-shaved, but with side-whiskers, and plentiful grey hair, worn rather long, and brushed sharply back from a face that bore an eager and vivid but kindly expression. His well-cut fashionable clothes can scarcely have come from any other source than Savile Row. These, together with spats and neat boots, all conveyed the impression of a man of the world rather than the pundit.

Certain characteristic incidents during these years under Huxley remain engraven on my memory, and each conveys its own sidelight on his activities and methods. That most deeply impressed was on the occasion of my first lecture, naturally a moment of trepidation for a beginner. The day before this event was due, a message came to me: "The Dean presents his compliments, and will you have any objection to his attending your first lecture?" I replied, perhaps straining the strict truth, that I should be happy to see him. He entered the lecture-room with me, conversing pleasantly. But he sat himself in the middle

of the front row, stretched out his legs, buried his chin in his waistcoat, and snorted at intervals. At the close of the lecture he said cryptically that he had been interested, and that I had told him various things he had never heard before. Then came the reward for this trying ordeal, for he said: "There is one thing I should like to tell you as a young lecturer: lecture your audience, do not lecture your black-board." He went up to the black-board, took a piece of chalk and began to draw, then looking over his right shoulder he said: "Cultivate this attitude." I have never forgotten that advice, and have passed it on to many other beginners. But why do not all seniors help their junior staff by similar kindly advice?

This whole incident showed a virile but genial method in handling a junior. He left it open to me to say "No." But being present he laid himself out to be helpful. So far as I remember, he never again entered my lecture-room or laboratory while work was going on. He had sampled the methods of his junior, and then left him to work them out in his own way. Doubtless, however, he had his own means of judging whether the work was going on satisfactorily.

Another incident was the sitting of a committee, called together by General Donnelly, to devise a scheme for exhibits at the Bethnal Green Museum, illustrative of natural products of use to man. Huxley was the chief figure, but with him were Chandler Roberts-Austen, Guthrie, Judd, Church, and others. After general principles had been laid down, Huxley told us that he intended to take the pig, and to show by



From a photograph by H. Huxley, about 1881

exhibits in museum cases how every part of its body is made useful: bristles for brushes, the hide for saddle-covers and book-binding, as well as the rest for human food. He then suddenly turned to me and asked: "What will you do for the Vegetable Kingdom?" I replied I would undertake an exhibit of the Cruciferae. Unfortunately, so far as I am aware, the scheme was never pursued; but it illustrated Huxley's desire to make the science of ordinary life real to the general public.

In 1883 Huxley was appointed president of the Royal Society, and I thought it my duty to offer congratulations to my chief. Rather shyly I made my little speech, but was rather taken aback by the rejoinder: "You might as well congratulate a man on carrying two hundredweights on his shoulders." Clearly what impressed him was not so much the dignity of the supreme official position in science in Britain as the obligations which it laid upon him; and these, as we have good reason to believe, he carried out to the detriment of his health.

In 1884 the chair of botany at Oxford was vacant, and I asked Huxley's advice as to entering a candidature for it. He strongly urged that "Any young man who has confidence in himself should stay in

London. It is the centre of scientific life, where he will hear of novelties as they arise." He then illustrated his thesis by a brief sketch of his own life, which I regret I did not write down at once. He told me of his difficult position after return from the expedition in H.M.S. *Rattlesnake*, of his ill-health, and his literary efforts as a young married man. He wound up with the phrase: "And I don't suppose there was a more unpromising couple in London than we were." Considering his final success, this illustration greatly strengthened his argument; but I entered a candidature, and failed before my senior, Sir Isaac Balfour. Here again we see Huxley's sympathetic treatment of a younger man. But his general thesis may be held as still open for debate.

After assuming the presidency of the Royal Society Huxley's attendance at the Royal College became less regular. Rumours of ill-health began to circulate, and his teaching duties devolved more and more upon his senior assistant, Howes. Meanwhile, I left South Kensington in 1885 on appointment to Glasgow, and excepting for his last appearance in proposing the vote of thanks to Lord Salisbury for his presidential address in 1894, at the British Association at Oxford, I rarely saw him after that date.

### The Beginnings of Instruction in General Biology.

By Prof. S. H. VINES, F.R.S.

MY personal association with Prof. Huxley was connected with the courses of instruction in general biology which he devised and conducted in the early 'seventies at South Kensington. By his biological friends he was ever after known as "the General," a tribute, no doubt, to the value of the idea by which these courses were inspired, the idea of the unity of life. Zoology and botany were making rapid progress at the time, but rather in water-tight compartments: the students of the one science felt but little interest in the other, failing to recognise the close similarity of the aims, the problems, and the methods of the two sciences. Having propounded the doctrine of protoplasm as the physical basis of life, Huxley logically inferred that animals and plants represent two divergent lines of protoplasmic evolution from a common starting-point. It was to illustrate this line of thought that the courses in general biology were planned. They involved the detailed comparative study of a series of animals and of plants, representative of various stages of evolution. The original programme was published as a small book known as Huxley and Martin's "Elementary Biology."

The first of these courses was held in the summer of 1873, and lasted for about six weeks. The daily intro-

ductory lecture was given by Huxley himself, and then the students, who were, I believe, elementary school teachers, went into the laboratory to verify for themselves the facts which had been described in the lecture. This they did under the guidance of a staff of demonstrators, who, on this occasion at any rate, were fully worthy of their chief. Unless I am mistaken, among them were the late Sir Michael Foster, the late Prof. Rutherford, Sir E. Ray Lankester, Sir William Thiselton-Dyer, and the late Prof. Lawson, of Oxford. The laboratory work covered two hours in the morning and two in the afternoon; it was sufficiently arduous to tax the energies of both students and demonstrators.

The first course was so successful that it was repeated in the following summer (1874), but with a different staff of demonstrators. Zoology was represented by the late Profs. H. Newell Martin and Jeffrey Parker, and botany by Sir W. Thiselton-Dyer and myself. I was then an undergraduate of Christ's College, Cambridge, and was offered the appointment by Newell Martin, who was a senior undergraduate of the same college. It was a great, almost oppressive, honour to be introduced to Huxley as one of his junior assistants. However, he was most kind and encouraging, though he did not spare criticism when necessary on making

his rounds in the laboratory. His lectures were a revelation to me, so lucid, so well-proportioned, so convincingly expressed. It was altogether a memorable experience, an invaluable apprenticeship in the art of teaching science.

The course of general biology was not, I believe, repeated at South Kensington, successful as it had been: it was, however, reproduced widely throughout the country, and still survives in some places—Cambridge is, I think, one. But it seems to me that the original glory has departed: the great leading idea of the unity of life has been lost sight of, and the course tends to degenerate into the uninspired study of the details of structure of certain typical animals and plants.

Nevertheless, the fresh impulse that Huxley thus

gave to biological study has not failed to produce lasting effects. It materially affected the teaching and study of botany in Great Britain, directing attention to the fact that plants are of interest, not merely from the systematic, *hortus siccus*, point of view, but also, and chiefly, because they are living things the mode of life of which, though different from that of animals, is equally the manifestation of those fundamental properties of the protoplasm of which both plants and animals consist. Botanical courses on these lines were conducted at South Kensington in the spring of 1875 and in the summer of 1876 by Sir W. Thiselton-Dyer, in both of which I acted as one of the demonstrators. Afterwards, a special professorship of botany was instituted there to carry on the tradition.

### Huxley and Evolution.

By W. BATESON, F.R.S.

FROM time to time I am asked by students, botanical and other, Was Huxley a great man? Did he do very much? I have a clear answer. I say, if you were a zoologist you could not ask that question, for you would know that Huxley worked over almost the whole face of zoology, and that so much of modern classification and terminology is the product of his logic and "organised common sense" that if we turn to any text-book earlier than about 1850, when Huxley's operations were beginning, we feel ourselves in zoological pre-history. It is all very well to say that anybody who chose to look could see that starfishes, Holothurians and Medusæ should not be classed together and with various other creatures, but neither Lamarck nor Cuvier did notice that Radiata and Polyps were preposterous medleys. Most of the great groups at one time or another came under Huxley's attention, and his instinct for order and his morphological sagacity were so sure that his judgment has been generally accepted by his successors.

I am aware, however, that on the occasion of this centenary the services we are to commemorate are not those which he rendered as a great architect of academic morphology. To the world, scientific as well as lay, Huxley is chiefly famous as the champion of evolutionary doctrine, whose vigorous and skilful advocacy counted for so much in obtaining the favourable verdict of the public. The opportunity was prodigious. He had a splendid case. Among his opponents were persons of the highest consequence, some of whom for this particular contest were equipped with nothing beyond the complacency of ignorance. He was, moreover, willing to take pains—a very formidable qualification in a controversialist. Such papers as Huxley on Suarez, Huxley *v.* Gladstone in

the matter of the Gadarene swine or the order of vertebrate succession, provided a rare entertainment, of which the like—to compare small with great—had scarcely been seen since Bentley's Phalaris; though without disrespect to the victors in those decisive engagements, one may perhaps doubt whether either of them went about their daily business loaded with quite the weight of extensive and peculiar learning which upon emergency they produced with perfect spontaneity to the confusion of their opponents.

Looking back over that critical period, we wonder at the persistent bad leadership of the opposition. The only weapon by which they might have impeded progress was one they never seem to have thought of using, namely, silence. Had authority contented itself with observing that similar notions had been promulgated not infrequently for nearly a century before without meeting the general approval of naturalists, adding possibly a few soothing and carminative words to the effect that, whether true or not, these technicalities left the fundamentals of revelation undisturbed, but disclaiming any particular interest in the topic, trouble would have been long postponed, perhaps avoided indefinitely.

If that course had been pursued, we professionals would be remembering Huxley as a sound naturalist and an acute observer, though scarcely perhaps on a scale amounting to a celebration. Geneticists certainly are not likely to forget him. Through all his triumphant vindications of the doctrine of descent as a general proposition, he never forgot the weak spot. Again and again he declared it to exist in "the group of phenomena which I mentioned to you under the name of Hybridism, and which I explained to consist in the sterility of the offspring of certain species when crossed

with one another" (1863).<sup>1</sup> In the same year he writes to Kingsley: "From the first time I wrote about Darwin's book in the *Times* . . . until now, it has been obvious to me that this is the weak point of Darwin's doctrine. He *has* shown that selective breeding is a *vera causa* for morphological species; but he has not yet shown it a *vera causa* for physiological species. But I entertain little doubt that a carefully devised system of experimentation would produce physiological species by selection, only the feat has not been performed yet."

Nothing that has happened since at all mitigates the seriousness of this criticism. The words quoted above may indeed be used to-day with an even stronger emphasis, though I doubt whether many of those best acquainted with modern genetics are so sanguine as Huxley was, that by the most carefully devised system of experimentation are we in the least likely to produce physiological species by selection. Rather have we come to suspect that no amount of selection or accumulation of such variations as we commonly see contemporaneously occurring can ever culminate in the production of that "complete physiological divergence" to which the term species is critically applicable. With entire candour Huxley reiterated that if this were the necessary and inevitable result of all experiments, the Darwinian hypothesis would be "shattered." Nothing was to be gained by glozing that difficulty. The grounds of the evolutionary faith are otherwise so solid that no alternative can ever be considered again; but chiefly for the reason so prominently named by Huxley, which modern genetical research has so greatly reinforced, the representations of that process which found such facile acceptance in his time no longer satisfy us.

On another occasion Huxley's admirable scientific judgment came near to rendering a great service, if not to science, at least to Darwin. The manuscript of the Pangenesis chapter, published at the end of "Animals and Plants," was submitted to him for an opinion (1865). What he then replied we do not know, for the letter is not published among his correspondence, being, I imagine, lost. But its tenor may be inferred from the sentence in Darwin's answer, "I do not doubt your judgment is perfectly just, and I will try to persuade myself not to publish." Huxley unfortunately weakened and replied that he had not at all meant to stop the publication, that he really should not like to take that responsibility, etc. So this curious chapter appeared, revealing that Darwin must have gone through life never apprehending the significance of cell-division, and almost without curiosity as to what was then already known of the process by which

animals and plants are reproduced. From other passages the modern reader of course would suspect as much, but if Huxley's discretion had prevailed, illusion need not have been totally destroyed.

As we can now see very well, both Darwin and Huxley in a sense mistook the character of their own work. They were assembling materials and laying a foundation, well and truly, be it said, though, like so many of their contemporaries, they imagined they were finishing a permanent edifice. Huxley himself, as he stands in Collier's picture, confidently facing his audience with the skull in his hand, might almost be the model for Max Beerbohm's "The Future—as the XIXth Century saw it." Looking forward, the Victorian type sees his successor, the duplicate of himself, the same features, same proportions, same frock coat, only magnified enormously. In biology at least there were no misgivings in those days, and few attempts to look far behind the obvious. Genetics, the experimental study of developmental mechanics, and, in general, the prosecution of more rigorous analysis, are an independent development, related to what went before about as much as the arch was to the architrave.

Late in life Huxley attacked the Gentians, and after a year's work published his "Notes and Queries" on that natural order.<sup>2</sup> It was considered an admirable discussion, and I can believe it to be so. The whole series of genera are there arranged in a logical order of inter-relationships based on the differentiation of the floral parts in adaptation to fertilisation by insects. To be sure, as he explicitly states, this consideration cannot be supposed to have decided the numerous other features of habit, or of leaf-structure, or the various other anatomical points in which the plants also differ, but he has "little doubt that, with larger knowledge, analogous causes will be found operative in all these cases." The "larger knowledge" to which Huxley is looking forward is to be the same kind of knowledge, only more of it. The knowledge his successors seek is of a wholly different order. No one better than Huxley knew that some day the problems of life must be investigated by the methods of physical science if biological speculation is not to degenerate into a barren debate. That ambition, which in Huxley's day was a pious and impotent fantasy, has become the immanent and informing hope in which all modern evolutionary research is directed. The Gentians well illustrate the change; for I suppose we would resign ourselves to ignorance of the teleological meaning of their floral apparatus if some one would give us an analysis of the mechanical forces by which the flowers of *G. campestris* develop their parts in fours, and demonstrate how they

<sup>1</sup> "Collected Essays," vol. 2, 1893, p. 463

<sup>2</sup> Linnean Journal—Botany, 24, 1887.

are related to the mechanism by which many closely related species divide their flowers into fives.

Yet if our immediate aims are so distinct, our ultimate purpose is the same. In Huxley we shall always reverence one in the fruits of whose victory for truth and liberty we are still sharing. The direction of public opinion is a most precarious art, demanding

imagination and a large knowledge of human nature. Of that art Huxley was an incomparable master; and the fact that thousands are now engaged without hindrance in the prosecution of those researches to which he devoted his whole life, is the direct result of his eloquence and courage. "Other men laboured, and ye are entered into their labours."

### Huxley as Evolutionist.

By Prof. J. ARTHUR THOMSON.

WHEN Darwin published his "Origin of Species" Huxley sprang at once to his side, and he never wavered in his loyalty to the general idea of evolution, towards which he had been previously not more than critical. On palæontological grounds alone, he tells us, he was quite convinced; and in the "flash of light" that Darwin gave him, he saw the evolution doctrine as "a statement of historical fact." This was partly because Darwin had a workable causal hypothesis behind the modal formula. As a champion of the evolutionist position Huxley did great service, in his American addresses for example, in showing how the formula fitted the facts, and in rebutting such criticisms as were begotten of ignorance and misunderstanding. He was a fearless protagonist, "a braw fighter." He certainly quickened the not unnaturally slow acceptance of the evolution idea.

Huxley was also favourable to the theory of natural selection, "the selective power, which Mr. Darwin has satisfactorily shown to exist in Nature"; but he was doubtful whether it was strong enough to bear the heavy burden laid on its shoulders.

"How far 'natural selection' suffices for the production of species remains to be seen. Few can doubt that, if not the whole cause, it is a very important factor in that operation; and that it must play a great part in the sorting out of varieties into those which are transitory and those which are permanent."

Why was Huxley doubtful? Because, as he says, the logical foundation of the theory of natural selection is incomplete until it has been definitely proved that selective breeding can give rise to varieties infertile with one another. Moreover, he said, it is necessary to know more about the raw materials on which the selective process operates—about the variations in fact and their causes. He had other difficulties, but these two were most important—the ordinary reproductive discontinuity of species and the nature of variations. Thus his fine-edged scientific temperament forced him to a *tatige Skepsis*—"doubt which so loves the truth that it neither dares rest in doubting, nor extinguish itself by unjustifiable belief." As Prof. E. B. Poulton

has shown in detail, Huxley did not in the course of his life become either colder or warmer to what he called the *hypothesis* of natural selection. He continued to think that it was part of the answer to the evolution problem.

In regard to variations, Huxley was quite definite in distinguishing them from impressed "modifications." Speaking of Ancon sheep and the like, he said:

"Doubtless there were determining causes for these [varieties] as for all other phenomena, but they do not appear; and we can be tolerably certain that what are ordinarily understood as changes in physical conditions, as in climate, in food, or the like, did not take place and had nothing to do with the matter. It was no case of what is commonly called adaptation to circumstances; but, to use a conveniently erroneous phrase, the variations arose spontaneously."

It seemed to Huxley intelligible that minor variations should arise, "as intelligible as the general similarity, if we reflect how complex the co-operating 'bundles of forces' are, and how improbable it is that, in any case, their true resultant shall coincide with any mean between the more obvious characters of the two parents."

Impressed by such cases as the sudden appearance of the short-legged Ancon sheep or of hexadactyle children, Huxley kept hold of the idea of discontinuous or saltatory variations: "We believe that Nature does make jumps now and then, and a recognition of the fact is of no small importance in disposing of many minor objections to the doctrine of transmutation." He said that Darwin's position would have been stronger than it is if he had not embarrassed himself with the aphorism, *Natura non facit saltum*. It comes to this, that Huxley foresaw part of the truth that there is in the mutation theory; he had a glimpse of *Natura saltatrix*.

There is no doubt that Huxley believed in "an internal metamorphic tendency" as well as "an internal conservative tendency." The second is organic inertia and is expressed in individual stability and in the hereditary persistence of a specific organisation. As to the metamorphic tendency—to give rise to something new—Huxley thought of "a struggle for existence within the organism," an interesting anticipation of Roux's

"Kampf der Teile im Organismus" and of Weismann's "Germinal Selection." "Multitudes of these [molecules], having diverse tendencies, are competing with one another for opportunity to exist and multiply; and the organism, as a whole, is as much the product of the molecules which are victorious as the Fauna, or Flora, of a country is the product of the victorious organic beings in it."

One of Huxley's striking remarks was that the primitive protoplasm was like "a sort of active crystal with the capacity of giving rise to a great number of pseudomorphs; and I conceive that external conditions favour one or the other pseudomorph, but leave the fundamental mechanism untouched." As to the transmissibility of somatic modifications, he had an open mind—"I am too much of a sceptic to deny the possibility of anything"—but we do not know that he ever found any trustworthy evidence to lead him towards the affirmative position. In 1890 he wrote: "I absolutely disbelieve in use-inheritance as the evidence stands."

Huxley was evidently prepared to find evidence that "variability is definite, and is determined in certain directions rather than others by conditions inherent in that which varies." Like Darwin, he also attached importance to the idea of "correlated variation"; "the selective process carries the general constitution along with the advantageous special peculiarity," and the general constitution may express itself in variations that are *indifferent* as well as in those that are useful.

In his autobiography, certainly a remarkable document, Huxley says: "I am not sure that I have not all along been a sort of mechanical engineer *in partibus infidelium*." The only part of his medical course that really and deeply interested him was physiology, "the mechanical engineering of living machines." He speaks of the extraordinary attraction he felt towards "the study of the intricacies of living structure." He confesses: "I am afraid there is very little of the genuine naturalist in me"; and one cannot but remember how, when some zoologist asked him as to his manner of dealing with birds in a current course of lectures on comparative anatomy, he answered: "I intend to treat them as extinct animals."

We refer to this outlook because it explains, perhaps, what seems to us a marked limitation in Huxley's view of the "struggle for existence." No doubt he tells us that the struggle is more than "a sort of fight"; no doubt in the appendix to his Romanes lecture he refers to gregariousness, sociality, enforced "renunciation of self-will," and "rudimentary ethical process" among higher animals; but the fact remains that he gives the student an impression of animate Nature as "a vast gladiatorial show," "a Hobbesian warfare,"

"a dismal cockpit." Therefore man, he argued, in his endeavours after social progress must set his face in a direction opposite to that of Nature's regime.

Darwin's picture of the struggle for existence was broader and subtler. The formula must be used, he said, in "a large and metaphorical sense," covering all the thrusts and parries that organisms make against environing limitations and difficulties. It includes not only internecine competition for food and foothold, but endeavours to give the family a good send-off in life. Darwin's wide experience as a naturalist, studying the life of creatures as it is lived in Nature, made him not only clear in regard to the doom of the unlit lamp and the ungirt loin, but also appreciative of the time and energy that many animals expend in other-regarding activities which secure the safety and welfare of the offspring. The struggle for existence rises into an endeavour after well-being; and man must learn from Nature's tactics rather than seek to reverse them.

It seemed to Huxley that "perhaps the most remarkable service to the philosophy of Biology rendered by Mr. Darwin is the reconciliation of Teleology and Morphology, and the explanation of the facts of both which his views offer." The old teleology which pictured man's eye being made as it is in order that man should see clearly "has undoubtedly received its death-blow." "Nevertheless, it is necessary to remember that there is a wider Teleology, which is not touched by the doctrine of Evolution, but is actually based upon the fundamental proposition of Evolution"—to wit, a continuity of orderly becoming, according to definite laws, from the "primitive nebulousity" onwards.

Whatever primeval order of Nature we choose to start from, it implies the possibility of the origin of adaptable organisms and the establishment of a stable *Systema Naturæ*; it implies the possibility of man and his science; and, as Aristotle taught, there can be nothing in the end of a natural process of becoming which was not also present *in kind* in the beginning, whatever beginning we begin with. The one death-watch in the wooden clock, to use Huxley's comparison, said that he could find nothing but "mechanism." If this corresponds to the position of descriptive naturalism, it is quite right. But if the same death-watch went on to say that the clock was not contrived for a purpose, he would be quite wrong. But wrong in another direction would be the death-watch who maintained that the final cause and purpose of the clock was to tick, just as he himself did. The safer position would be to conclude that the purpose of the clock lay beyond the purview of beetle faculties. So, said Huxley, we must not be too sure that the cosmic ticking we hear is evolution's increasing purpose. These matters seemed to him out of reach.

## Huxley as Anthropologist.

By Sir ARTHUR KEITH, F.R.S.

IN the spring of 1857, two and a half years before the "Origin of Species" was published, certain events occurred in London which compelled Huxley to apply himself to the scientific study of the human body. As a student of medicine he had learned the elements of human anatomy, but from the time he left the Medical School of Charing Cross Hospital in 1846 until 1854, when he obtained his first teaching appointment in the School of Mines, his investigations had been confined to the structure of invertebrate animals. At the School of Mines he very quickly saw that if he wished to share in the prevalent movement which was then interpreting the faunas of past geological periods, he had to become a master of vertebrate anatomy. He planned a campaign which would carry him from one end of the vertebrate kingdom to the other, and proceeded to carry it out with all the greater zest because he knew it must bring him into open conflict with the first anatomist of the time—Richard Owen.

The contingency which Huxley had foreseen came about in the spring of 1857, while he was still in the prime of early manhood—being then in his thirty-second year—while his chosen antagonist, Richard Owen, was twenty-one years his senior and enjoying, as an undisputed right, the throne of leadership amongst British anatomists. At an early phase of his career Huxley realised that there was neither peace nor place for him in England so long as Richard Owen occupied that throne. The conflict, as we shall see, developed round man's status in the animal kingdom. In the course of the conflict which ensued, Owen was tumbled from his throne and Huxley emerged as the first anthropologist of his time. The future, when it is able to look back more calmly on these mid-Victorian happenings, will not wish to strip a single bay leaf from Huxley's brow, but it will desire to return to Richard Owen his crown. It was his arrogance and pride, certainly not his ignorance, which made him pay so dearly for two sad blunders he made in the spring of 1857.

Historians know well that the political events of a period cannot be interpreted aright unless the personalities of the statesmen of the time are known. It is so in science; the critical phase of Huxley's career cannot be understood or interpreted unless the contemporary doings and personality of Richard Owen are realised. In 1857 Owen found himself, for the first time in his life, without a pulpit and an audience: 1856 had turned out to be the critical year of his life; until then he had been Conservator of the Museum of the Royal College of Surgeons in Lincoln's Inn Fields;

there for a score of years he had given courses of lectures, each course opening up some fresh section of the animal kingdom. This pulpit he had voluntarily abandoned because of a conflict with his masters—the Council of the College. The Council intended that its Museum should be conducted so as to serve the needs of medical men; Owen, in direct opposition to the Council, planned to make the Museum a national institution of natural history and comparative anatomy, controlled and supported by Government. He used his great influence at Court and in political circles to forward his aim. By 1856 he had made his office at College so uncomfortable that he determined, at the age of fifty-two, to transfer himself to the British Museum. That transfer ultimately culminated in the erection of the Natural History Museum at South Kensington, but its first effect was to deprive him of a platform whereon he might unload his ever-growing knowledge. Looking round, he had himself installed as a professor of palæontology at the School of Mines—the subject and place which Huxley was then making his own.

Herein Owen's arrogance led him to commit his first great blunder of 1857. Huxley sharpened his rapier and bided his time. At every opportunity he seized for investigation such subjects as had yielded fame and name to Owen; and when he seized them he shook them, and in the shaking Owen's errors dropped out so publicly that no one could fail to note them. Theories of skull and skeleton, over which Owen had been so elated when Huxley left the Navy, were mercilessly and publicly torn to tatters by his young antagonist. The monograph on the pearly nautilus, on which Owen first rose to fame, was shown to be blemished by errors. Owen had devoted himself to the study of the great fossil edentates of South America; Huxley gladly seized an opportunity provided by Owen's old College to show that he also could handle them as an expert. From 1830 onwards, Owen had made a special study of the anatomy of anthropoid apes; by 1857 he believed he had left little for others to discover concerning their structure. It was after 1857 that Huxley applied himself to the same subject. He did so because of a grievous and almost incredible blunder which Owen made in February of that year.

In 1857 Owen offered the Council of the Linnean Society a paper "On the Characters, Principles of Division, and Primary Groups of the Class Mammalia." The first part of the paper was read on February 17; in this Owen outlined his proposal to classify mammals according to the size and conformation of their brains. In his scheme, man was to be excluded from the order

of Primates, where Linnæus had placed him side by side with apes and lemurs a century previously, and placed far apart from apes in a separate sub-class. Owen demanded this separate place for man on account of the features of the human brain. We must look again at that passage in which Owen made his fatal blunder—the passage which turned Huxley to the comparison of ape and man, and became his stepping-stone to fame as an anthropologist.

"In Man the brain presents an ascensive step in development higher and more strongly marked than that by which the preceding sub-class [that to which were assigned the anthropoid apes] was distinguished from the one below it. Not only do the cerebral hemispheres overlap the olfactory lobes and cerebellum, but they extend in advance of the one and further back than the other. Their posterior development is so marked, that anatomists have assigned to that part the character of a third (occipital) lobe; *it is peculiar to the genus Homo, and equally peculiar is the 'posterior horn of the lateral ventricle' and the 'hippocampus minor' which characterise the hind lobe of each hemisphere.*" (The italics are ours.)

This passage appears on pp. 19, 20 of the Proceedings of the Linnean Society (1858, vol. 2, Zoology), and that part of the passage we have placed in italics was a gross error. How Owen came to make such a blunder is not easily explained; it certainly was not for lack of opportunity of knowing the truth. Not even Huxley's merciless logic could wring from Owen an admission of blundering. He carried himself with the infallibility of a statesman in power. Huxley accepted Owen's error as a gift from the gods and shaped it into a lethal weapon. In reality the blunder was trivial, but to onlookers it seemed that man's soul was at stake, and Owen believed himself to be its chosen defender.

If it be difficult to understand how Owen came to make elementary blunders in the anatomy of the human brain, it is harder still to see how he could reconcile two statements which he set down on the page from which we have already quoted. One statement is: "I am led to regard the genus *Homo* as not merely a representative of a distinct order, but of a distinct sub-class of the Mammalia for which I propose the name 'Archencephala.'" The other statement, which is here cut down to its briefest form, is this: "I cannot shut my eyes to the significance of that all-pervading similitude of structure—every tooth, every bone, strictly homologous—which makes the determination of the difference between *Homo* and *Pithecus* the anatomist's difficulty." In one breath Owen announces that the difference between man and apes is so great that man must be assigned to a separate sub-class; in the next he declares that it is a matter of the utmost difficulty to draw a sharp line between ape and man.

Owen clearly wished to leave himself the right to hunt with the hounds as well as to run with the hare; Huxley determined that his antagonist should run with the hare, and run hard.

After Owen's paper to the Linnean Society was published, matters moved quickly towards a crisis. Huxley immediately set to work to equip himself with an ample supply of trustworthy ammunition and of followers, and was soon able to force Owen into action. Until then Owen believed that the ideas he entertained concerning the origin of man were daringly "advanced"; more than once dignitaries of the church had become alarmed over his tenets and teaching. In his youth he had basked in the sunshine of the smiles of the great Cuvier. He drew his inspiration from France. He believed, as Cuvier did, in a special creation of man: he also believed in a modified form of evolution—one in which "a predominating will produced structures for a final purpose." Huxley, on the other hand, so far as he drew inspiration from any source beyond his mother wit, drew it from Germany; the writings and methods of Johannes Müller, of von Baer, and of Koelliker were his chosen exemplars. Tradition and preconception regarding man's origin he had designedly thrown overboard, and resolutely determined to follow to whatever goal the evidence led him. Owen was blinded by the glamour of his own fame, which prevented his seeing the reality of the issues of the conflict which was being forced on him. He could not conceive that any one would be so foolhardy as to attempt to scale the battlements which the church had thrown round man's origin and divinity. Yet it was this foolhardy attempt which Huxley was to lead. He scaled the fortifications successfully and brought man back as a victim for the anthropological laboratory.

After 1857, as I have said, events moved quickly. In 1858 Darwin and Wallace read their conjoint paper at the Linnean Society; Owen was president of the British Association, and Huxley took the opportunity of blowing Owen's archetypal theory of the skull sky high. Late in 1859 came the publication of Darwin's "Origin of Species"; this provided Huxley with prime ammunition for his campaign. His guns, trained on the target of "special creation," were infinitely more effective weapons when loaded with Darwin's ammunition than when merely charged with the powder of pure negation. By 1860 Huxley had compared man and ape, bone for bone and structure for structure, and was then ready to place his conclusions before an audience of working men. Owen scoffed at this assay as an attempt to foist the gorilla on working men as their ancestor. It was in this year that Huxley made the meeting of the British Association memorable. There he slew Bishop Wilberforce with his wit and Owen with the "hippo-

campus minor"—a trivial but, as events proved, a murderous weapon.

Then in 1861 Huxley pursued his search into the manner in which the human and animal bodies are developed. Man, he found, had no prerogative in his mode of origin; his body came into existence by passing through

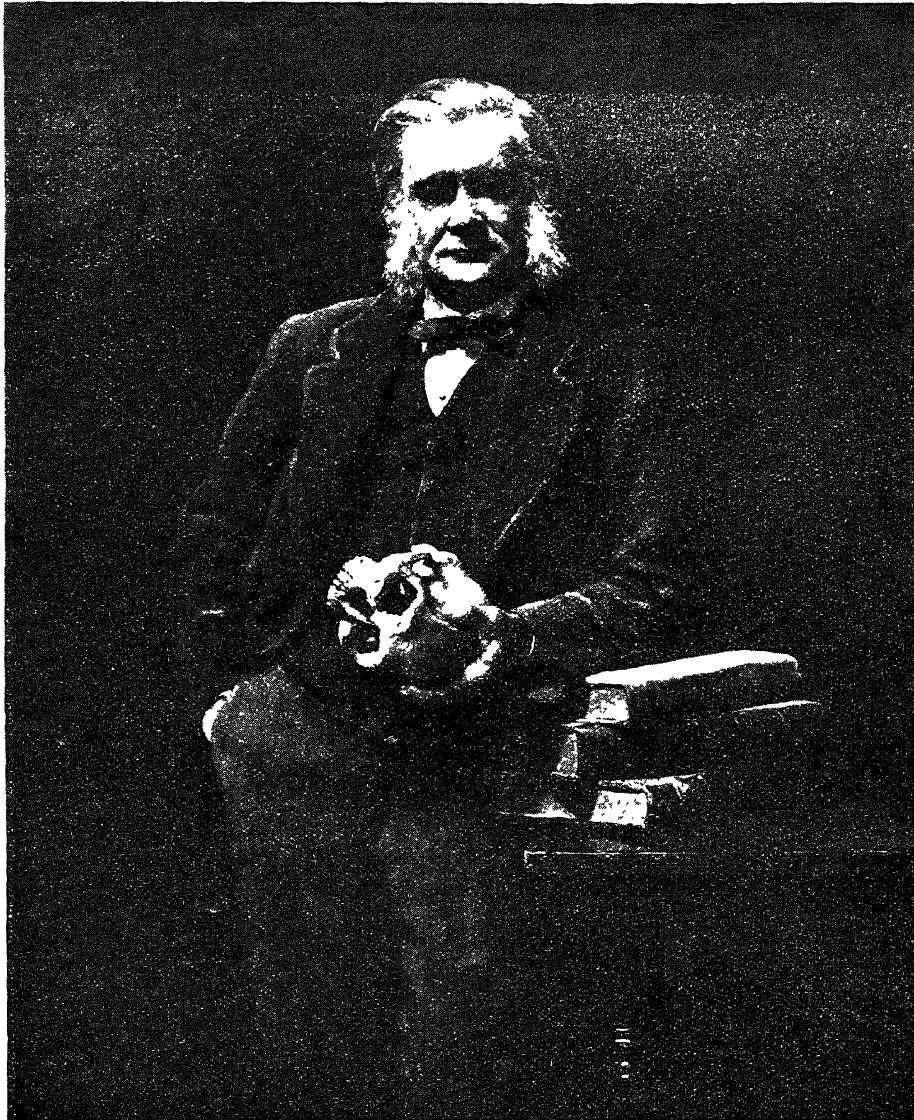
similar stages in the womb as did that of the dog. In January of 1862 he went to Edinburgh to lay before the Philosophical Institute a detailed analysis of man's zoological status. In the summer of the same year he made a searching examination of such fossil human skulls as were then known. They were only two in number: one had been found at Engis in 1833, the other was discovered at Neanderthal in 1857. The

Neanderthal calvaria he regarded as merely a primitive variety of the modern human skull. Its discovery had revealed the presence of a brutal race of modern (neanthropic) man in Europe at an unknown but certainly ancient date. For the accurate description and comparison of this skull he found it necessary to invent and apply a series of new methods; he sought to rationalise craniology. Then early in 1863 he issued

the studies which Richard Owen's statements had compelled him to make in book form—"Evidence as to Man's Place in Nature." Huxley was the author of this classic, but Owen was its unconscious instigator.

When we look round for another biological treatise in which is given as complete and as convincing proofs of

a thesis as were produced by Huxley in "Man's Place in Nature," we can think of only one which will stand comparison namely Harvey's account of the "Movement of the Heart and Blood." Such a comparison brings out a feature of Huxley's temperament. Harvey was Darwin's intellectual cousin; having set their evidence in its just order, they left it to speak for itself. Huxley, on the other hand, favoured the



Photo]

1883

[Henry Dixon and Son.

From a portrait painted specially for the National Portrait Gallery and presented, in August 1893, by Huxley's son-in-law, the Hon. John Collier. Reproduced by kind permission of the Hon. John Collier.

methods of St. Paul and of Hume; it was not sufficient for him merely to set out his evidence in the clearest of terms and the most logical of orders; he felt it necessary to drive his arguments home with his unerring intellectual hammer.

"Man's Place in Nature" has been studied now for sixty-two years; it reads as fresh and true in 1925 as in 1863. Its main thesis was to rehabilitate man in the

zoological position to which Linnæus had assigned him, namely, the status of a family in the order Primates. That status is now accepted by all. Anatomists are agreed that Huxley understated his case when he said that the structural differences which separate man from the gorilla are no greater than those which lie between the gorilla and the lower primates. Certainly our knowledge regarding man's relationships to anthropoid apes has increased enormously since "Man's Place in Nature" was written; we now know many extinct forms of anthropoid apes and fossil types of human beings, but such discoveries, while they extend, do not invalidate the truths for which Huxley contended except in one instance. This exception concerns the status of Neanderthal man. Huxley regarded this form of humanity as merely an extreme variant of modern man, while, in opposition to him, Prof. King of Galway maintained that the simian characters of the skull were so pronounced that Neanderthal man must be regarded as belonging to a separate and extinct *species* of mankind. Events have proved that King was right.

In writing "Man's Place in Nature," Huxley laid the basis for a true science of anthropology. By writing that book he rendered a great service to knowledge, but of even greater moment was the victory he then won in the cause of liberty. Until Huxley appeared as their champion, anthropologists scarcely dared to state the truth as they found it; when he had silenced theological opposition, they were free to apply to the study of man the same methods as they employed in the study of other animals. He paved the way for Darwin's "Descent of Man," which appeared in 1871.

With the publication of "Man's Place in Nature," the first phase of Huxley's anthropological investigations came to an end, and in the same year, 1863, a curious combination of circumstances forced him into a second phase, one which was to last until 1871. In both phases his anthropological inquiries represented but side issues of his day's duty; his main zoological work went forward as usual. In 1843, when Huxley was in the second year of his medical studies, the Ethnological Society was founded in London; in 1863 it held its meetings in St. Martin's Place—on a spot now marked by the Irving statue. At this time its affairs had drifted into a precarious condition. The relation of the negro to the white man was being violently canvassed, and a young hot-headed fellow of the Ethnological Society, James Hunt, who wished to apply political methods to the study of races, carried off a large group of ethnologists to found a new society, the Anthropological. The saner members who remained in the old society prevailed on Lubbock, John Evans, Galton, and Huxley to join them. As a fellow of this society, Huxley gave his attention to the races of mankind. In 1864 he had

encircled the earth as a hovering anthropological hawk—noting the distribution of the "persistent modifications" of mankind, and as usual laid the first results of his survey before an audience of working men. The final result was published under the title of "The Methods and Results of Ethnology." This survey, if brief, is certainly comprehensive, logical and masterly, and has never been excelled. Darwin's theory helped him to explain much that was previously inexplicable. He applied to the study of human races the methods used by zoologists in the study of breeds of dogs. In his discrimination and classification of races he relied more on skin colour and hair texture than on form of skull, and in this, I think, the future—although not the present—will support him. He brushed the cobweb of racial tradition from the map of Europe and boldly declared there were but two racial stocks in Europe—a fair and a dark. The first he named the Xanthochroi; the second the Melanochroi. In each of these, round heads and long heads were found. So far as he could see, these two stocks had always been in Europe and no others. He recognised that there was a third racial element in Europe, the Mongolian, but this he regarded as eruptive and unimportant.

It may also be worthy of note—particularly as the subject is of present interest—that in this essay of 1865 the sceptical Huxley was a believer in "independent origins." He believed that all the world over, men were endowed with like faculties, and that "like faculties must tend to produce like contrivances."

In 1866 his friend, Mr. Samuel Laing, M.P., discovered in Caithness human remains which had been buried in stone-slab graves. These graves the discoverer believed to be of neolithic date, but they are now assigned to about the beginning of our era. Huxley gave a perfect description of the skulls and skeletons, and took the opportunity of expounding, for the first time, his conception of the racial composition of the British people. He brushed the traditional belief of Celt and Saxon aside. For him there were but two racial stocks in Britain—the same two as occupied the continent of Europe—Xanthochroi and Melanochroi. The fair-haired people, he demonstrated, had been in Britain long before the Saxon invasion. Huxley was always inclined to carry the simplification of his explanations to an extreme point. As a zoologist he could not accept the politician's conception of race, and yet we who have lived through the thirty years which have elapsed since his death have seen that the most violent racial animosities can arise between peoples of the same structural constitution. In the following two years, 1867, 1868, he was again studying human skulls and elaborating methods to elicit the exact nature of racial distinctions. Then, in 1869, in the hope of amalgamat-

ing the two rival societies—Ethnological and Anthropological—he accepted the presidentship of the former, and held it until their fusion was accomplished at the close of 1870. Studies of the races of America and of the peoples of India, made during the term of his presidentship, are lasting illustrations of the manner in which ethnological inquiries should be conducted and set out.

It so happened at this period that the "Irish question" had entered one of its acuter phases. On Sunday, January 10, 1870, Huxley gave an evening lecture on the "Forefathers and Forerunners of the English People." The thesis he expounded was that which he had broached in 1866, namely, that there were but two racial stocks in the British Isles—the fair and the dark. In his opinion the people of Ireland, of Scotland, Wales and England had been compounded out of these two stocks. He held that there were no means known to anatomists by which the body of a Celt could be distinguished from that of a Saxon. "If what I have to say in a matter of science," he informed his Sunday evening audience, "weighs with any man who has political power, I ask him to believe that the arguments about the difference between Anglo-Saxons and Celts are a mere sham and delusion." Having tried the effect of his facts and arguments on a popular audience, he then took them, as was his custom, before an expert tribunal, in this instance that of the Ethnological Society. In the following year, 1871, he issued his thesis in its final form under the title of "Some Fixed Points in British Ethnology."

The Sunday evening lecture led to a correspondence in the *Pall Mall Gazette* with a "Devonshire Man." I mention this correspondence here because it provides an example of Huxley's controversial methods. In his lecture he had flouted the idea that Devonshire men were preponderantly of Anglo-Saxon stock, and on this point was challenged by a "Devonshire Man." Huxley's reply is well known, but is worthy of quotation on this occasion.

"Sir, your correspondent, 'a Devonshire man,' is good enough to say of me that 'cutting up monkeys is my forte and cutting up men my foible.' With your permission I propose to cut up 'a Devonshire man,' but I leave it to the public to judge whether, when so employed, my occupation is to be referred to the former or to the latter category."

After 1871 Huxley's health became bad; he was deeply involved in matters educational, geological, zoological, physiological and sociological, and abandoned anthropological studies. It was not until 1890, when he had retired to Eastbourne, that he contributed to the *Nineteenth Century* a paper which showed that he had not lost his old interest in anthropology. The title of this paper was "The Aryan Question and Pre-

historic Man." As we read that article we see that Huxley's intellect had lost nothing of its great sweep and vigour; his gift of selecting from a confused mass of evidence the salient and significant facts amounts to genius; no barrister could excel his method of marshalling facts to prove a case. In this instance, the thesis he maintained was that, of all the peoples known to us, the fair-haired stock of northern Europe had the best right to regard themselves as the original Aryans, as the speakers of the mother tongue which in the course of time had become disseminated in daughter forms from India to Ireland. That theory was not new even in 1890; in later times it has been applauded and extended by German philologists.

When we read over at the present time the contributions which Huxley made to anthropology, we are struck by their modernity; very little of what he wrote requires to be deleted or altered. It is true that much could be added to the statements he made. Since his time our knowledge of the developmental and geological histories of man and ape have grown apace, but in most instances our increased knowledge leaves his broad truths unchallenged. No doubt the facts which we have learned concerning the antiquity of civilised life in Mesopotamia, Egypt, and Crete, and of the early spread of culture to western Europe, would have led him to reformulate his answers to certain problems. I am certain that the discovery of implements of human workmanship, in deposits of Pliocene date, would not have surprised him.

When we search for the means which so often guided him to the heart of the truth, we find them to lie within himself. No man ever purged himself more free of prejudice, preconception, and tradition than did Huxley. His controversial methods show us that he still retained in the outside world something of the original Adam; but inside his laboratory he attained as near the ideal of pure rationalism as is ever likely to be reached by any mortal biologist. His intellect was penetrating and balanced; his capacity to toil and to verify, unlimited. Because of these qualities his writings stand the test of time. There is perhaps a further explanation. He never permitted his imagination to stray far in front of his reason; he never gave his imagination free wing to open up new fields of knowledge or to outline a new or daring hypothesis. He had studied living matter in all its forms; in this respect there was no one in England during the nineteenth century who could be compared with him except Owen, and in precision of knowledge and in his familiarity with the physical forces which underlie the manifestations of life he was Owen's superior. These, I think, are the qualities which give to Huxley's contributions to anthropology and to all departments of biological knowledge a permanent value.

## Evolution and Man.

By EDWARD CLODD.

HUXLEY'S career from the dismal time of his boyhood when, as he said in a letter to Charles Kingsley, he was "kicked into the world without guide or training or with worse than none," to the closing years, the strenuous activities in which only death arrested, needs no "vain repetition" in this brief article. Its main purpose is to emphasise the deep significance of his contributions to a theory which if it works anywhere works everywhere.

As with Darwin after his five years' experience in the *Beagle* (when he sailed on that memorable voyage Huxley was a lad of six), so with Huxley's four years on board the *Rattlesnake*, there was laid the foundation on which his life-work was based. At the unusually early age of twenty-six, recognition of what he had done thus far came in his election to fellowship of the Royal Society, the presidential chair of which he was to fill thirty-two years later. Besides the nine volumes of his "Collected Essays," four big volumes of "Scientific Memoirs" witness to the amazing amount of work which he accomplished. The public has judged him only by the "Essays"; the specialist alone knows to what high place as a philosophical biologist the "Memoirs" bring evidence. In their preface to these the late Sir Michael Foster and Sir Ray Lankester say that

"Huxley produced so great an effect on the world as an expositor of the ways and needs of science in general and of the claims of Darwin in particular, that, some, dwelling on this, are apt to overlook the immense value of his original contributions to exact science. Ignorance as to this exists in so-called well-informed circles. In his capacity of editor of a book entitled 'One Hundred and One Great Writers,' the late Dr. Richard Garnett is responsible for the statement which describes Huxley as 'the man who makes few original contributions to science or thought, but states the discoveries of others better than they could have stated them themselves.' Another sciolist, who shall be nameless, calls him 'that uncouth pedagogue of science.'"

Huxley's public activities, which included much lecturing, frequently to working-men, date from 1854; but he came more to the front on the publication of the "Origin of Species" in 1859. *Annus Mirabilis*, for from that time the saying "old things are passed away, behold, all things are become new," is applicable. The story of the mixed reception of that book is an oft-told one and has passed into history. In a letter to Wallace, Darwin said, "if I can convert Huxley I shall be content." His wish had quick fulfilment. In the chapter on the reception of the "Origin of Species," which Huxley contributed to Darwin's "Life and

Letters" (vol. 2, ch. v.), he says, "My reflection, when I first made myself master of the central idea of the 'Origin,' was how extremely stupid not to have thought of that!" Pointing out what seemed to him a weak spot in the theory,<sup>1</sup> the disciple outstripped the master and filled the part of protagonist in a movement which was to change the current of thought on the absorbing question of man's origin, place, and destiny.

On the last page of the "Origin" Darwin ventured only a hint that man was not specially created. When the "Descent of Man" came out in 1873 he explained that his reticence was "due to the wish not to add to the prejudice against his views" (Introduction, p. 1). Anthropology, the youngest of the sciences, had made little advance. In his "Memories of my Life," Sir Francis Galton says that the horizon of the antiquaries was so narrow in his Cambridge days (1840) that "the whole history of the early world was literally believed by many of the best informed men to be contained in the Pentateuch." So late as 1855, experts refused to accept the evidence of man's antiquity and primitive savagery which M. Boucher de Perthes unearthed from the Somme valley; and it was not until 1884 that the British Association for the Advancement of Science accorded anthropology a section to itself. Until then it was admitted only by a side door; a sort of "tradesmen's entrance."

To return to Huxley. Sharpening beak and claws, he opened the campaign in 1860 (we all remember the famous duel between bishop and biologist at the British Association that year). He pushed the theory of organic evolution to its logical conclusion in a series of six lectures to working-men in London, followed by two lectures to the Philosophical Institute of Edinburgh. These were published in 1863 under the title "Evidence as to Man's Place in Nature." The gist of what he said is in this quotation from what may, without exaggeration, be called a revolutionary book.

"In view of the intimate relations between Man and the rest of the living world, and between the forces exercised by the latter and all other forces, I can see no excuse for doubting that all are co-ordinated terms of Nature's great progression from the formless to the formed, from the inorganic to the organic, from blind force to conscious intellect and will. I have endeavoured to show that no absolute structural line of demarcation wider than that between the animals which immediately succeed us in the scale can be

<sup>1</sup> "In my earliest edition of the 'Origin' I ventured to point out that its logical foundation was insecure so long as experiments in selective breeding had not produced varieties which were more or less infertile and that insecurity remains up to the present time" (*ib.* p. 198).

drawn between the animal world and ourselves, and I may add the expression of my belief that the attempt to draw a psychical distinction is equally futile, and that even the highest faculties of feeling and of intellect begin to germinate in lower forms of life" (pp. 1089, 1863 edn.).

It was with pride, warranted by the results of later researches, that Huxley in a letter to me thus referred to the book when arranging for its reissue among the "Collected Essays."

"I was looking through 'Man's Place in Nature' the other day. I do not think there is a word I need delete or anything I need add except in confirmation and extension of the doctrine there laid down. That is great good fortune for a book thirty years old, and one that a very shrewd friend of mine implored me not to publish, as it would certainly ruin all my prospects."

The friend was Sir William Lawrence, to whom Lord Eldon had refused an injunction to protect the rights of the author on the ground that his book entitled "Lectures on Physiology, Zoology and the Natural History of Man" controverted the Scriptures. That was in 1819.

The agitation which had been aroused by the lectures embodied in "Man's Place in Nature" was but a zephyr breeze when compared with the storm that raged round Huxley's lecture on the "Physical Basis of Life" which, exaggerating the offence, was delivered on a Sabbath evening in Edinburgh (November 8, 1868). In the limited degree to which people had thought about it, they had settled down with more or less vague understanding of it, into acceptance of Darwinism. Now their quiet was rudely shaken by this southern troubler of those "who were in ease at Zion," with his production of a bottle of solution of smelling-salts and a pinch or two of other ingredients representing the elementary substances entering into the composition of every living thing, from a jelly speck to man. Well might the removal of the stopper of that bottle take their breath away! Philosophers "so-called," and clerics alike, raised the cry of "gross materialism," never pausing to read Huxley's answer to the baseless charge, an answer repeated again in his writings, as in the essay in Descartes's "Discourse of Using One's Reason Rightly" and in his "Hume." He never wearied in insisting that there is nothing in his statements inconsistent with the purest idealism, and that our knowledge of matter is restricted to those feelings of which we assume it to be the cause.

Reference to the more important of Huxley's utterances would be incomplete if these did not include a few words of his lecture "On the Coming of Age of the Origin of Species," which was delivered at the Royal Institution on April 9, 1880. The occasion will not

be forgotten by those who were present. Huxley was at his best; his note was one of restrained, well warranted triumph. One pregnant suggestion was that "if the doctrine of evolution had not existed palæontologists must have invented it" (the same remark, it may be added, applies to morphology and embryology). Huxley's closing words were congratulations to Darwin that "he had lived long enough to outlast detraction and opposition" and to see that "the stone that the builders rejected had become the head-stone of the corner." On April 26, 1882, Darwin was buried in Westminster Abbey.

From the nature of the subjects on which Huxley worked during his closing years, polemics could not be excluded. He agreed that "they were always more or less an evil." But to fold hands when error and obscurantism pursue their baneful course is a greater evil; hence the succession of controversies in which he was involved with Dean Wace and Gladstone. They need not be touched on here. Two years before his death he revisited Oxford ("adorable dreamer and home of lost causes") to deliver his Romanes Lecture on "Evolution and Ethics." His thesis was that the endless struggle which runs through Nature is for the time being checked by an ethic that has its roots in sympathy begotten of knowledge.

In the "Life and Letters" Dr. Leonard Huxley gives a series of portraits of his father from early manhood to old age. To these can be added a copy of a photograph given in Mr. Tuckwell's "Reminiscences" of Oxford, taken in 1860. He is depicted in a well-creased frock-coat, light waistcoat and baggy trousers, necktie with wide bow; in one hand he holds gloves and a silk top hat, and in the other an umbrella. The whole effect is comical. He looks for all the world like a stump orator. Never did clothes so belie the man.

Huxley's home life was ideal. In the Marlborough Place days, Huxley (I quote from a letter before me) had "a way of making Sunday evenings pleasant by seeing friends who come in without ceremony to take tea at half-past six." At these gatherings one had admission to a household, the note of which was freedom and simplicity; "a Republic tempered by epigram," as he described it. To name those whom it was a privilege to meet would be only to compile an index of eminent names; for of the things said and heard there could be no record: no "chiels amang ye takin' notes to prent." I recall one Sunday evening when a black fog reduced the guests to two—Mrs. W. K. Clifford and myself. Supper over, Huxley took me into his den, when he lighted his briar-wood pipe, and talk about books followed. Browsing among these, I came on an odd lot of obsolete theological and philosophical volumes which he said he had relegated to

"a condemned cell." From another shelf I took down Hobbes' "Leviathan," which called forth the remark, "I like that old fellow, his masculine and clear style is a tonic." His own style is *sui generis*. True workman as he was, he said to me that a book of his never came hot from the press without his wishing that he could rewrite it. Of his devoted and talented wife he said that she would have made a mark in literature "but for the claims of their big family." Evidence of her gifts is supplied in the slender volume of her

privately printed poems,<sup>2</sup> a valued gift to those who hold her memory dear. It is from her "Browning's Funeral" that, at Huxley's request, these lines are inscribed on his tombstone.

"Be not afraid, ye waiting hearts that weep,  
For God still giveth his beloved sleep,  
And if an endless sleep he wills, so best"

"There were giants in the earth in those days," and Huxley was among them.

<sup>2</sup> Since published by Duckworth and Co. (1913).

### Enduring Recollections.

By Dr. HENRY FAIRFIELD OSBORN,

Research Professor of Zoology, Columbia University; Senior Geologist, U.S. Geological Survey;  
President, American Museum of Natural History.

I CANNOT decline to join in these tributes to my revered teacher, although the invitation from the editor of NATURE finds me on vacation near the Coral Reefs of Florida and the Bahamas, far away from libraries, note-books, and letter files. It seems best to outline the enduring personal impressions of the memorable winter of 1879-1880 when the great anatomist and natural philosopher was in the full tide of his power.

Thoroughness, forcefulness, clearness, sincerity, and humour were the five outstanding qualities of Huxley as a lecturer. My two very full volumes of lecture notes, illustrated by copies of all his coloured black-board drawings, display these qualities throughout, and I cherish them because they recall his dominant personality and also give a complete survey of our knowledge of that period of the zoology of invertebrates and vertebrates, of the cell, of embryology, of the palæontology and dawning phylogeny of the vertebrates. While at the time Huxley was on the crest of the wave of knowledge, these notes show how limited was our horizon in 1879 as compared with the vastly broadened horizon of this year of his centenary. His lectures, accompanied by daily laboratory verification under the genial influence of the younger W. Newton Parker and the omniscient prosector George B. Howes, were designed as a foundation for medical anatomy and physiology as well as for research work in comparative anatomy and palæontology.

When called to Princeton in 1880 as assistant professor of comparative anatomy, I introduced the Huxley method of extemporaneous lectures and laboratory verification to my college classes, and ten years later when called to Columbia University to lay the foundations of the department of zoology, I introduced the same method to the larger graduate and undergraduate classes. Thus through my undergraduate and graduate courses between the years 1880 and 1908, the broad Huxleyan method has been widely extended

over the United States not only to my own students, such as McClure, Strong, Matthews, McGregor, Gregory, Lull, Osburn, Bensley, Forster-Cooper, Beebe, and many others, but to my grand-students, as I like to term the many able and forceful young men whom my own students are turning out from year to year. I cannot give exact figures, but I know that more than six hundred students are now profiting annually by this Huxleyan method in anatomy, neurology, embryology, and palæontology, in American, Canadian, and British universities.

Breadth and depth, culture from every source, lack of dogmatism, faith in the educational value of science without prejudice to the classics, these were the key-notes of Huxley's influence as a teacher and writer. From sheer necessity Huxley failed in one very important respect, namely, personal contact with his students; so far as I recall, he came through the laboratory not more than once a week, whereas Francis Balfour at Cambridge was at your elbow every morning. Thus Huxley had no time to encourage original thought or discussion or research with his students.

While having all the charm of extemporaneous discourse, his lectures, like his public addresses, were very carefully thought out, and fact was sedulously separated from opinion and hypothesis. On the dangers of extemporaneous speaking, Huxley once told me that he gave the closest attention to preparation beforehand, lest he should be carried away by the so-called "inspiration of the moment" to say something not strictly accurate. He also confided to me that he had never been able to overcome the apprehensive feeling known as "stage fright" before making a public discourse—a feeling that his talk was already as familiar to the audience as to himself, and therefore neither new nor interesting. This apprehensive feeling seems to be the best physiological prelude to a brilliant and convincing address. Our most easy and brilliant

American public speaker of recent times, Joseph H. Choate, also confided to me that before addressing a great audience he never could overcome his "stage fright" and extreme uneasiness.

When Huxley made his incomparable rejoinder to Lord Salisbury's attack on "the comforting theory of evolution" at the Oxford meeting of the British Association of 1894, he gave the impression of consummate ease and enjoyment, but he told me the following day that he had never found it more difficult to convey a compliment at the manner and form of the address combined with a complete dissent from the entire substance of it. On an earlier occasion at the annual dinner of the Royal School of Mines in 1879, when the presiding officer was so tactless as to criticise the policy advocated by Huxley of removal from the crowded quarters of Jermyn Street to the greater space of the South Kensington Science Schools, every eye was on Huxley, who as the guest of honour sat at the speaker's right; when he very quietly rose from his chair as the presiding officer concluded, some may have expected a characteristic rejoinder; certainly none of us foresaw the eloquence of silence, for bowing to the speaker, Huxley walked out of the dining hall as one could have heard a pin drop, and thus expressed his most emphatic disapproval.

Before leaving the subject of Huxley's candour and scientific caution and the extraordinary breadth and scope of his teachings and writings, from the widest ranges of Hume's philosophy to the anatomy of the amoeba, I cannot refrain from directing attention to him as a leading and, in our specialistic days, much needed exemplar of the educational principle that in the highest grade of instruction we must be both extensive and intensive; we must cover a very broad field in an authoritative manner, we must penetrate very deeply in a single field. As to the latter element of intensive thought, Huxley was the first to observe that through palæontology we can penetrate far more deeply both in space and time than in any other branch of zoology. It was his personal misfortune and our own good fortune that he was so incessantly interrupted by public and educational affairs and the constant pressure for his opinion as a publicist on every theologic and scientific question of his day. It is no exaggeration to say that in his "Life and Letters" he has left priceless records of the conflicts of opinion during Darwin's time, records that are now eagerly sought and read by theologians and scientists alike, for their veracity as well as for their brilliance. Never is a truth sacrificed for an epigram; rather do truths shine out through his epigrams.

If in this polemic period of his life we perceive less scientific generalisation than we should expect from a

man of such imagination and creative power, we may attribute it, first, to the lack of repose of mind necessary to generalisation; secondly, to the rudimentary and scattered materials of palæontology as he knew them in 1879. Huxley lived to see in the distance evolution as established by palæontology, but he did not live to enter this promised land; he came nearest to it in his brief visit to America and eager survey of the Yale Museum collections of Marsh establishing the evolution of the horse. Now that we have taken full possession of the promised land of palæontology, vertebrate and invertebrate, and see before our eyes the secular origin of mutations, of species, of genera, of families, of orders, almost of classes, we wish we could summon the great spirit of Huxley back to life and walk along with him among the countless fossils we have gathered from every age in every continent, in their ascending order from the immovable Lingula to the ever mutable Homo. The palæontology of 1925 answers many of the biological problems of Huxley's day, such as the limits of variation, the powers of natural selection, the presence of determination rather than chance in evolution, about which he always expressed himself in the most guarded manner. In fact, the logical nature of Huxley's mind kept him in doubt as to the adequacy of Darwin's explanations of evolution, while in the larger sense he was the greatest and most able exponent of Darwin's doctrines.

In previous papers I have told many of the Huxley stories lodged in my memory. Without doubt some of Huxley's lecture jokes were annuals, like those for which Oliver Wendell Holmes became famous in his anatomical lectures at Harvard. Others were spontaneous and of the moment. He loved stories upon himself, as of his popular lecture on the brain and the one elderly dame whom he especially picked out to address as apparently the only intelligent member of an evening audience. As the lecture closed this dame advanced for a question: "Professor, there is one point you did not make quite clear to us: Is the cerebellum inside or outside of the skull?" This was a crusher. On his lack of orthodoxy, according to a story of youthful domestic experience which he told my wife, he was never rebuked so forcibly as in the early years of his married life by an intoxicated cook. After Mrs. Huxley had tried in vain to dislodge the cook from the kitchen floor, Huxley descended to the kitchen and with full assurance of masculine supremacy said: "Bridget, get up and go to your room, you ought to be ashamed of yourself." Whereupon Bridget gave a kick and replied: "I am not ashamed of myself, I am a good Christian woman, I am not an infidel like you."

On the personal side, it was my especial good fortune

as a young American palæontologist to be singled out of the class of one hundred students for a brief introduction to Charles Darwin on the only occasion in which he visited Huxley's laboratory, also to receive the hospitality of Huxley's delightful home at a time when his family circle was still unbroken. I treasure the visiting card on which he sketched the location of his home, 4 Marlborough Place, and invited me to come every week to his Sunday evening high-teas, as he called them. This gave me the opportunity of meeting Mrs. Huxley and all the members of the talented family of sons and daughters, as well as the many clever and interesting artists and men and women of letters who surrounded the hospitable table. Here I saw the real personality of the man with all the cares and responsibilities of life thrust aside for the thorough enjoyment of conversation on every subject, rich and full of kindly humour, and with an inexhaustible fund of experience and wise counsel. He loved to imagine that he was entirely ruled by his family and spoke of himself as chicken-pecked as well as hen-pecked. No one could have foreseen that he was so soon to break down in health and to be compelled to relinquish the load which was too great even for his broad shoulders and indomitable will and energy.

I saw Huxley later on two occasions and recall his witticism regarding the Gladstone articles in the *Nineteenth Century* on the alleged close correspondence between the actual order of evolution and the first chapter of Genesis. He said: "Osborn, that article of Gladstone's made me so angry that it acted favourably on my liver and caused me to discharge a large quantity of black bile which gave me almost immediate relief from the torpidity of that organ from which I had long been suffering." We enjoyed a long and delightful conversation at his home, in which he gave my wife an ever memorable talk upon his views as to the immortality of the soul. Finally, in Oxford in 1894, at the garden party of the British Association, we met for the last time, when he was very much broken in health, and said to me sadly: "I am no longer able to keep up with the progress of biology; it has now gone far beyond me." One of my cherished letters is an appreciation from Mrs. Huxley of the address entitled "A Student's Reminiscences of Huxley," which I gave to the student assembly of the Marine Biological Laboratory soon after his death. I trust in the present brief tribute that I may have expressed again in some degree what I owe to his friendship and to his example.

### Contributions to Vertebrate Palæontology.

By Sir ARTHUR SMITH WOODWARD, F.R.S.

IN his brief autobiography (1893) Huxley mentions that in 1854, when Sir Henry de la Beche, the Director-General of the Geological Survey, offered him the posts of palæontologist and lecturer on natural history, he refused the former and accepted the latter only provisionally because he "did not care for fossils." He was much more interested in physiology, and did not at that time appreciate the purely morphological facts of palæontology. In a lecture at the Royal Institution in the following year, he even expressed the opinion that the study of fossils had not made any real contribution to the philosophy of zoology.

"There is," he remarked, "no real parallel between the successive forms assumed in the development of the life of the individual at present, and those which have appeared at different epochs in the past. . . . The particular argument supposed to be deduced from the heterocercality of the ancient fishes is based on an error, the evidence from this source, if worth anything, tending in the opposite direction."

After a very brief experience of his new field of research, however, Huxley began to be absorbed in the study of the fragmentary remains of extinct animals, and for more than thirty years he held his official position on the Geological Survey making

fundamental contributions to palæontological science. He was at first associated with J. W. Salter, who had a special knowledge of the fossil invertebrata and was skilled in the naming of genera and species which were needed by the geologists for determining the relative ages of rocks. He accordingly turned to the fossil vertebrata which had until then been comparatively neglected by the surveyors, and he soon discovered their value not only as time-markers but also as affording important insight into the true relationships of many groups of animals which were otherwise difficult to understand.

Huxley's earliest paper, published in co-operation with Salter in 1855, was on some supposed fish-shields from the Upper Silurian (Downton Sandstone) near Ludlow, and this led to a series of investigations of the earliest fishes which by 1861 culminated in several entirely new conceptions. A detailed description of the microscopic structure of the head-shields of the Devonian Cephalaspis and Pteraspis showed that these really belonged to vertebrate animals, and none could be the shells of cuttle-fishes as had been asserted. A still more exhaustive study of the ganoid fishes from the Old Red Sandstone of Scotland was summarised in the now classic "Preliminary Essay upon the

Systematic Arrangement of the Fishes of the Devonian Epoch," which was issued as a memoir of the Geological Survey in 1861. Here, for the first time, the fringe-finned fishes (Crossopterygii, as they were then termed) were clearly separated from the higher and later types of ganoids, and a new idea was thus introduced into the classification of fishes. We now recognise that all the earliest fishes had lobate fins; that during the evolution of the more modern types these lobes have gradually become shortened up and replaced by long dermal fin-rays; that in the fishes which passed into amphibians the lobes were transformed into five-toed limbs.

Huxley maintained his interest in the Crossopterygian fishes for several years, and in 1866 he published another Survey Memoir on one particular group which he was the first clearly to define, that of the Coelacanthidæ. After describing in detail the members of this group belonging to successive geological periods, he showed that they ranged in time from the Lower Carboniferous to the Upper Cretaceous with no essential change. He had been impressed for some years with the numerous "persistent types" of life, as he termed them, but the Coelacanth, with their complex and in many respects anomalous osteology, were the most remarkable of the long-lived groups which had then been discovered.

While studying the Devonian fishes, Huxley had been struck by the close relationship of some of them with the possible ancestors of the amphibians. He thus became interested in the earliest undoubted representatives of the latter class, which had been named Labyrinthodonts by Owen. He was, in fact, a pioneer in the investigation of the earlier Labyrinthodonts of the Carboniferous period, and he first described the now familiar *Anthracosaurus* and *Loxomma* from England and Scotland, besides an important series of small members of the same group from the Irish Coal Measures, and skulls from South Africa.

At the time when Huxley was devoting special attention to the fishes from the Old Red Sandstone of Scotland, specimens of these fishes were being found near Elgin in rocks which seemed to be of the same age as others containing the bones of fossil reptiles. He was accordingly induced to examine this question, and was soon able to prove that the two series of sandstones were really distinct, those containing the reptiles being of the Triassic period. In 1859 and 1869 he showed that the Elgin fossil reptile which he named *Hyperodapedon* also occurred in Triassic rocks in the south of England and in India, and when describing a complete skeleton from Elgin in 1887 he confirmed his previous impression that this early reptile was very

closely related to the small rhynchocephalian *Sphenodon* which still survives in New Zealand—another "persistent type." A detailed description of many reptilian remains from the Elgin sandstone was given in a well-illustrated memoir published by the Geological Survey in 1877.

The bony scutes of one of the Elgin fossil reptiles, *Stagonolepis*, had been mistaken by Agassiz for the scales of a ganoid fish, and it was not until Huxley (simultaneously with Owen) recognised their true nature that their special interest was appreciated. They proved to belong to a reptile which in many respects suggested an ancestral crocodile. Huxley was thus led to examine the fossil crocodiles, and one of his most noteworthy papers was that "*On Stagonolepis Robertsoni*, and on the Evolution of the Crocodilia," published by the Geological Society in 1875. He showed, among other features, how the crocodiles had gradually acquired the secondary bony palate which enables them to drown their prey beneath water. It seems to be the earliest attempt to discover the genealogy of a group of reptiles, and Huxley emphasised the fact that, although he felt he had determined the successive stages through which the crocodiles had passed, he "did not suggest that the progression had been effected through the forms with which we happened to be acquainted."

It was natural to turn from the supposed ancestral crocodiles of the Trias to the Dinosauria, with which they are closely related. Huxley accordingly took part in the early discussions as to the correct interpretation of the skeleton of the Dinosauria, which had been completely misunderstood when these reptiles were first discovered. With Cope and Phillips, he was the first to appreciate the bird-like construction of the hind limbs of many of the Dinosaurs, such as *Iguanodon*. He even ventured to state that "if the whole hind-quarters, from the ilium to the toes, of a half-hatched chicken could be suddenly enlarged, ossified, and fossilised as they are, they would furnish us with the last step of the transition between Birds and Reptiles; for there would be nothing in their characters to prevent us from referring them to the Dinosauria." Subsequent research has not yet resulted in the discovery of the links which were doubtless anticipated when the foregoing statement was made, but there can still be no doubt as to the close connexion of the earliest Dinosaurs with the ancestry of birds.

Huxley had few opportunities for research on fossil mammals, though his papers on *Macrauchenia* (1861) and *Glyptodon* (1865) may be specially mentioned as models of exposition. He closely followed the researches of others, however, and so long ago as 1870, in an address to the Geological Society, he quoted with

approval certain pedigrees of the horse and other hoofed mammals which had been made out by Gaudry, Rüttimeyer, and others. On his visit to America he studied the great collection of Tertiary mammals which Prof. O. C. Marsh had accumulated in the Peabody Museum of Yale University, and he helped Marsh in preparing the material for the latter's classic paper on the evolution of the horse in North America. Huxley's influence on the progress of palæontology, indeed, often

extended beyond his own publications. The mere systematic work of defining and naming genera and species never had much interest for him; but he always keenly followed research which was guided by a clearly pre-determined problem. He had the peculiar faculty of deciding what was "worth while" at the moment, and his own writings on fossils, as well as those which he inspired, are all among the most important contributions to palæontology of his generation.

### Structure and Evolution in Vertebrate Palæontology.

By Prof. D. M. S. WATSON, F.R.S.

THAT Huxley was a great palæontologist cannot be disputed, but it is singularly difficult to estimate the extent of his influence and to determine the place that he holds in that group of students who, in the years following the publication of the "Origin of Species," brought to the study of fossil animals new ideas and a new spirit which revolutionised its methods and its aims.

The pre-evolutionary palæontologists, of whom Owen was the most distinguished English representative, had given most detailed and accurate descriptions of the skeletons of many individual extinct animals; and had in some cases gone on to discuss their appearance and habits of life on the basis of an analysis of their structure.

The extraordinary wealth of personal knowledge of muscular anatomy which Owen possessed renders his essays in this direction still of the greatest interest: but the bulk of the work of this period is of no interest save as a mine of facts, and indeed in many cases consists solely of short and valueless descriptions of new species.

Huxley's work stands in the greatest contrast to that of Owen, and indeed to that of all who had preceded him. In no single case did he describe a fossil simply because it was new. Every fact which he recorded was used for some definite purpose, for the elucidation of a point of morphology, or for its bearing on evolution. Thus his papers are still valuable and readable, not for the facts which he records (indeed, most of his information is drawn from the published work of other palæontologists), but for their spirit, and for the interpretations of data which they contain.

The work which perhaps best illustrates Huxley's methods is the paper called "Preliminary Essay upon the Systematic Arrangement of the Fishes of the Devonian Epoch." Here Huxley begins with an original account of the structure of the skeleton in certain fish from the Upper Old Red Sandstone. This account, though in the main accurate, is not comparable either for precision or completeness with the somewhat

earlier description by Pander of similar fish. It would appear that Huxley used his less perfect specimens of *Glyptolæmus* very largely because they afforded a collateral corroboration of Hugh Miller and Pander's earlier accounts.

Being thus assured of the reliability of his data, Huxley goes on to a masterly analysis of the peculiarities of the Osteolepids, shows that they form a large group of fish, possessing a characteristic structure in head and fins, but very variable in body form. He shows that in the main, *Dipterus* is allied to them, and points out that only two living fish were then known, which had paired fins of the same "Crossopterygian" pattern. Of these fish, one, *Polypterus*, was definitely placed in the same group with the extinct forms, the other, *Lepidosiren*, being correctly compared with *Phaneropleuron* and *Ceratodus*, the latter then only known from fossil teeth. It is clear that Huxley regarded this group as close relatives of the Osteolepids. Finally, he adopts a suggestion of Egerton's, and with perfect justification adds the *Cœlacanth*s to the "Crossopterygii."

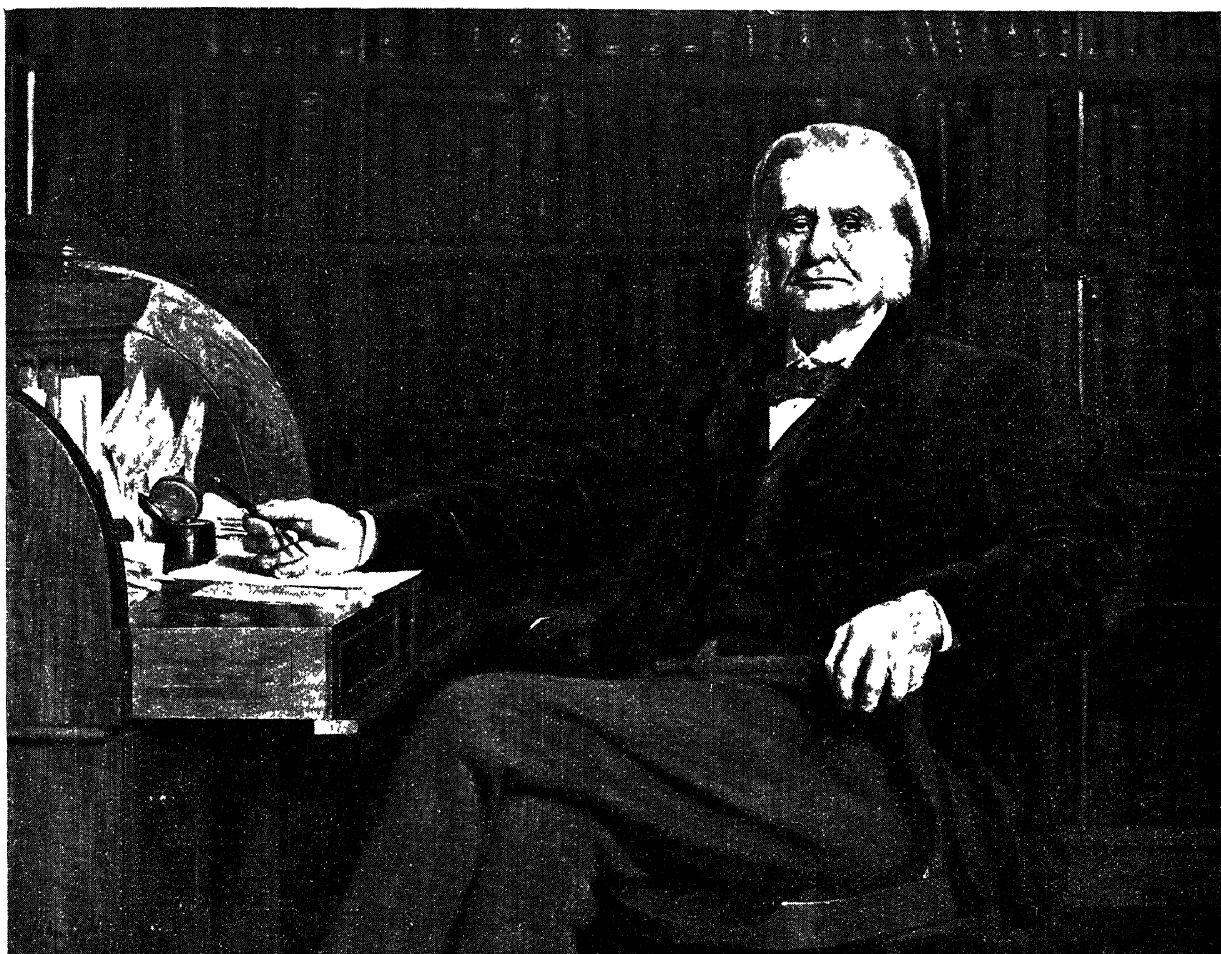
So far the paper is a model of sound method, and has been one of the foundation stones of fish classification; but in the second half Huxley instituted a comparison between the *Arthrodeir*, *Coccosteus*, and the *Siluroids*, pointing out many resemblances, without apparently any suspicion that they are purely superficial and are superposed on a completely different fundamental structure.

In this paper, published in 1861, and even in others of later date, Huxley is engaged as a pure morphologist and taxonomist, concerned solely with the facts of structure of individuals, and a classification based on direct resemblances. He does not, and with the material at his disposal could not, discuss any evolutionary matters. Huxley's evolutionary outlook first appears in his work on *Stagonolepis*, a crocodile-like animal from the Trias of Elgin, whose structure is still incompletely known. This creature is represented by bones, in the main isolated and badly preserved, im-

bedded in a hard sandstone, and in studying it Huxley made use of a technical method—the removal of the bones and the making of artificial casts from the holes so left—which was carried much farther by his associate E. T. Newton, and is now one of the most widely useful of all modes of study. Huxley pointed out the thoroughly crocodilian appearance of the armour of *Stagonolepis*, turning aside in a series of small papers to give a full account of the dermal armour in many recent

nearly resembling the modern ones than did the earlier forms.

Huxley used the evidence so brought forward to divide the group Crocodilia into three grades, distinguished by their evolutionary stage, each division being in the broad sense ancestral to that which came after it. This was, I believe, the first attempt to establish a horizontal division of a group on a definitely evolutionary basis.



Photo]

[Henry Dixon and Son.

1890.

Huxley in his study at 4 Marlborough Place, London, N W, where he did so much of his work. All the details, the chair, the desk, the papers on it, and the books on the shelves behind him are faithfully represented. The books behind his head are mostly Darwin's works. Reproduced by kind permission of the Hon. John Collier.

and fossil crocodiles. He showed that the vertebrae and limb bones exhibited the same affinities and then pointed out that, whereas the modern crocodiles have their palatal nostrils at the hinder end of the mouth, *Stagonolepis* and *Belodon*, then recently described by v. Meyer, resembled the lizards in the anterior position of these openings. Then, and it is in this feature that the novelty of the paper lay, he shows that in the Jurassic crocodiles, figured by Eudes Deslongchamps, and in a new skull from the Wealden, they lay in an intermediate position, the Cretaceous animal more

Huxley's palaeontological work covered the widest possible range: representatives of all the classes of vertebrates were described by him, and he was continuously looking for intermediate forms the structure of which would serve to connect them together. It was from this viewpoint that he studied the Dinosaurs, finding in them so many structural resemblances to the birds, that he regarded them, as of all animals, the most nearly intermediate between birds and reptiles.

The palaeontological work for which Huxley is perhaps most generally known is that on the evolution of the

horse, work in which he felt that, for the first time, we came near a real linear ancestral succession. To the data of this story he added nothing, but for the first time he arranged the then known fossil horses and horse relatives in their order of appearance, and showed how gradual was the reduction of the ulna and fibula. He recognised immediately the importance of Marsh's discovery of *Orohippus* and predicted the discovery of a five-toed horse ancestor, which still remains to be discovered.

As a palæontologist engaged in the actual work of examining, describing, and interpreting fossils, Huxley, although he takes an honourable place, has no pre-eminence. His work in this respect is perhaps not so good as that of his great rival Richard Owen. In his power of determining the structure of fossil fish he was not the equal of C. H. Pander, and none of his work is comparable with that of W. Kovalevski on fossil "ungulates," work permeated through and through by an evolutionary spirit, and directed continuously by an interest in function and habits of life which never appears in Huxley's palæontological work.

But Huxley's reputation is solidly based on those essays, of which his two addresses to the Geological Society are the chief, in which he directs his attention to a critique of the postulates which underlie all palæontological work. His reduction of Cuvier's Law of correlation of structures to a mere empirical generalisation, to which many exceptions could be pointed out, removed what would have been a stumbling-block in the further development of the science. His clear

recognition of the difference between what he called intercalary and linear types amongst intermediate forms is a contribution of the first magnitude to the philosophy of the science; it lies at the base of all the later work on the filiation of extinct animals.

Huxley's distinction between homotaxy and contemporaneity, between rocks of different regions which contain identical or comparable faunas and those of the same age, is a fundamental one, necessary for a true appreciation of the evidence of fossils as to horizon, although it now appears probable that in most cases homotaxial formations are actually sensibly contemporaneous. Nevertheless there are cases in which it does appear that the occurrence in two widely separate localities of animals of identical evolutionary stage does actually imply that these beds in that area from which the animals migrated are earlier than their homotaxial equivalents in the other region.

Thus Huxley, in his palæontological work, is to be regarded as a philosopher, searching in the great mass of fact accumulated by his predecessors and contemporaries for facts which he could bring to use for the establishment of a morphological idea, for the improvement of a classification, or for use as evidence in favour of evolution.

He was a critic, a man of most judicious mind, his caution being shown nowhere so well as in his failure, in 1862, to find any facts in palæontology to support the evolution theory, and at the time he worked he conferred an inestimable benefit on his science by his sure establishment of its intellectual foundations.

### Geological Thought and Teaching.

By Prof. W. W. WATTS, F.R.S.

HUXLEY'S services to geology were mainly through his palæontological work, both in his original research and in his critical review of the work of others, largely with a view of testing its bearing on evolution. As he said on one occasion, "the sole direct and irrefragable evidence of the method whereby living things have become what they are is to be sought among fossil remains." Like Darwin, he was somewhat disappointed by the want of definiteness of some of this evidence, but, on the other hand, he was able to show that among certain types of life, phylogenetic chains could be made out. His faith in geological evidence is shown by his separation of the Elgin Sandstones from the Old Red Sandstone with which they had been formerly classed, and the placing of them in the New Red Sandstone division on the faith of their fossil reptilian remains.

When secretary of the Geological Society in 1862, Huxley was called upon, owing to the absence of the

president, Mr. Leonard Horner, to deliver the annual address. In this he undertook the "wholesome though troublesome and not always satisfactory process which" is termed "taking stock." He directed attention to the number of "persistent types" in the animal and vegetable kingdoms, and the comparatively small amount of change from the earliest times in the major divisions of life-forms recorded as fossils. He clearly saw that the oldest known fossils were by no means the earliest forms of life, and that evolution demanded the existence of still older faunas and floras, some of which have since been established, though we are still far from knowledge of the beginnings of life on the earth. In the course of this address, Huxley examined and criticised the physical and palæontological evidence at the disposal of the geologist for establishing contemporaneity of strata in different parts of the globe, and showed that anything like exact evidence of synchrony was impossible of attainment. Existing faunas

in different parts of the world differ now from one another at least as much as successive geological faunas. He therefore advocated that the term "homotaxis," signifying similarity of order, should be substituted for contemporaneity as expressing more exactly the facts of the case.

The suggestion thus made has not been widely adopted among geologists working on stratigraphical geology, for several reasons. The geological scale, even in its most modern development, is not a delicate one in comparison with that of other histories, the periods of time represented by even small thicknesses of rock being long, and in the case of those most accurately zoned, of exceptional length. Wide-reaching migration is of course a slow process, but, expressed in terms of thickness of deposit, it is sufficiently quick to introduce no very serious error in paralleling widely separated formations with each other.

The more striking distributional facts are concerned with the larger and higher animals, and those possessed of poor facilities for migration. The geologist, having tested the more slowly migrating types, has been driven to depend on more lowly and comparatively obscure organisms for his time indexes, and he chooses marine forms, of planktonic or pseudo-planktonic habit, with the greatest facilities for migration, and least sensitive to climatal variation. Then the geologist realises that his primary object must be to get out exactly the rock succession in each area studied, and the easiest and most satisfactory method is to establish steps as nearly comparable as may be with some type area. Thus the comparison of deposits becomes increasingly exact and certain, and it then becomes possible for the first time to recognise geographical influences, to make out the facts of distribution as it affects individuals and groups, and to note cases of acceleration or retardation.

It is necessary after all (as with a currency) to take some standard, even a fluctuating one, and it is the task of the geologist to select that one in which the least possible variation is to be expected. It is not a little interesting to note that in his last address to the Geological Society (1870) Huxley speaks with appreciation of Barrande's doctrine of "colonies," a doctrine which for years held back detailed geological progress, and, in some of its consequences, seemed to stultify evolution. This doctrine, with all its unfortunate consequences, was destroyed by delicate British zonal research, carried out on the assumption that organisms were the best things that could be used as time-markers, and that, if well selected, they would provide a means of correlation, and a framework of contemporaneity sufficiently elastic to provide a basis of future research.

Huxley's first presidential address to the Geological

Society, in 1869, was on wholly different lines. He spoke as advocate for geological science against the demand that "a great reform in geological speculation seems now to have become necessary." Clearly he was nettled by this reference to "speculation" and the refusal to admit that these speculations were founded on lines of reasoning to which a certain amount of respect was due. He opened with a masterly account of the early stages of geological thought as expressed in the schools of "catastrophism" and "uniformitarianism," and showed that these had given way to an "evolutionary" system, founded on that of Kant, which included the better parts of both. Then he proceeded to deal with the three branches of Lord Kelvin's argument, the tidal retardation of the earth, the age of the sun, and the cooling of the earth from a state in which life would have been impossible on it.

The first argument Huxley brushed aside on evidence presented by himself, and on other evidence either quoted or adduced by Lord Kelvin, as introducing compensations which it is necessary to take into account. The arguments founded on the loss of heat by the sun and the earth he did not combat, but was prepared to admit that the history of the world, as known to geologists, might have been accomplished in the hundred million years or so allowed by Lord Kelvin. Taking the total thickness of sedimentary rocks containing traces of life, as then known, at 100,000 feet, he pointed out that a history of one hundred million years would only require the deposit of one-thousandth part of a foot, or little more than one-hundredth part of an inch per year. No geologist would consider this rate excessive, especially for the types of sediment to which this estimate applies. As for biological evidence, "biology takes her time from geology. If the geological clock is wrong, all the naturalist will have to do is to modify his notions of the rapidity of change accordingly."

It is perhaps fortunate that Huxley had not to meet on this occasion Lord Kelvin's later estimates, for they could not have been met on the same lines. It has been necessary to wait until the physicists themselves have discovered a source from which the loss of heat is made good by the radio-active processes occurring within the earth.

The influence of Huxley's association with Tyndall is betrayed by his communication of observations made by himself in Switzerland on the structure and movements of glaciers. He was particularly interested in the veined structure of glacier ice and the evidence of pressure afforded by it. Afterwards he and Tyndall worked together and they are conjoined in a paper on the subject in the *Phil. Trans.* in 1857.

The interest in the sea-bed which Huxley acquired

as naturalist on the expedition of the *Rattlesnake* showed itself in his appreciation of all deep-sea work, including that of the *Challenger*, on which he wrote. It also appears in his popular lecture on "A Piece of Chalk," in which he pointed out that the deep-sea calcareous oozes give the best explanation of the wide extension, the great thickness, and the peculiar character of the Chalk.

In this lecture, as in another, also given to working men, on a piece of coal, Huxley displayed his wonderful gift of taking some new method of technique, describing the results obtained by it, and then leading his audience on to wider questions, each stage of the discussion being closely reasoned, illustrated by apt and unexpected analogies, and leading to important influences on the lives of his hearers. Thus his "chalk" lecture led on to a convincing demonstration of the antiquity of this deposit in comparison with the history of mankind, and to an appreciation of the vast and slow changes in geography which geology reveals. Similarly, in the lecture on corals and coral reefs, he is not content with describing the evidence of earth movement they reveal, but discusses its bearing on problems of distribution of life. In his lecture on coal, too, after illustrating the spores and other plant tissues in coal, and inferring the conditions necessary to produce coal-seams, he turns to show how the apparently

reckless prodigality of Nature in dispersing these elements was the source of our coal supplies and of the industrial and economic applications which follow their exploitation.

One of the most important of Huxley's contributions to geology and geological teaching was the course of lectures which afterwards grew into his "Physiography." The purpose of this work is best stated in his own words.

"I conceived that a vast amount of knowledge respecting natural phenomena and their interdependence, and even some practical experience of scientific method, could be conveyed, with all the precision of statement, which is what distinguishes science from common information; and, yet, without overstepping the comprehension of learners who possessed no further share of preliminary educational discipline, than that which falls to the lot of the boys and girls who pass through an ordinary primary school. And I thought, that, if my plan could be properly carried out, it would not only yield results of value in themselves, but would facilitate the subsequent entrance of the learners into the portals of the special sciences."

It is not too much to say that the desire of the author has been attained, and that this book has had much to do with starting and stimulating many who have afterwards become distinguished in their work for geology and geography.

### Huxley's Contributions to our Knowledge of the Invertebrata.

By Prof. E. W. MACBRIDE, F.R.S.

HUXLEY'S original papers on the anatomy of the Invertebrata extend over a period of about thirty years, from 1849 to 1878. They deal with the most varied subjects, as, for example, the organisation of the Hydrozoa in general and of the Siphonophora in particular; the morphology of Heteropoda and Pteropoda amongst Mollusca; the anatomy and physiology of the rotiferan Lacinularia, the anatomy of the primitive trematode Aspidogaster, the embryology of the crustacean Mysis and of the parthenogenetic eggs of the Aphididæ amongst insects, and finally the anatomy of Pyrosoma, Doliolum, and Appendicularia amongst Tunicata.

The results recorded in these papers were embodied in a text-book entitled "The Anatomy of Invertebrated Animals," published in 1877. This was succeeded by the famous monograph on the crayfish published in 1880. In these two books we can see clearly displayed Huxley's outlook on the invertebrate division of the animal kingdom. In contradistinction to most of the zoologists of the day, he regarded classification as of secondary importance; what was primary and funda-

mental in his estimation was structure, and the only value of classification was to emphasise differences and resemblances of structure. Hence he gives no complete scheme of classification; he describes minor groups, and then discusses their probable affinities. Though, of course, he was a convinced evolutionist and one of the main protagonists for the cause in England, he held firmly that fundamental resemblances in structure constituted profound truths, the importance of which was entirely independent of the validity of any hypothesis as to how they had originated. He regarded the phylogenetic theories, which were fashionable in his day, as of no importance beyond serving to direct future research. As a consequence of this mental attitude he denied that there was any essential difference between so-called "artificial" and "natural" schemes of classification; he held that, on the contrary, they graded into another. He said that artificial classifications were based on some obvious external similarity, whereas natural classifications were based, so far as possible, on a consideration of all the likenesses and unlikenesses of the animals involved, and that those

features were selected as diagnostic marks which experience has shown to be indicative of a great many resemblances.

In both "The Anatomy of the Invertebrated Animals" and in "The Crayfish" Huxley takes up the extreme mechanistic attitude towards vital phenomena. In the former book he states that an organism is only a molecular machine of great complexity, and that to speak of vital force as anything beyond the sum of the physical and chemical processes which make up its working is as absurd as to speak of the horology of a clock. In "The Crayfish" he discusses the question as to whether the crayfish has or has not a mind, and declares it to be an insoluble problem. He points out the intimate connexion of mental ideas and images with language, and concludes that, since the crayfish has no language, it has nothing to say to itself or to anybody else, and that even if some of its actions are accompanied by an "awareness" distantly comparable to our own consciousness, this circumstance must be regarded as a mere epiphenomenon, and is of no avail to explain the actions in question; just as there are numerous things which we ourselves do without the intervention of consciousness.

Huxley's vigorous propaganda in favour of this way of looking at life had a profound influence on the scientific thought of his time, and this influence has by no means died out even yet. Nevertheless it is waning: when we learn from the works of Jennings that something of a rudimentary kind of intelligence—a questing after definite ends by varied means—can be detected in creatures so lowly as *Amœba*, we are not surprised that psychologists and biologists like MacDougall and Driesch come to the conclusion that there must be something analogous to a subject (a psychoid or entelechy) even in them. We may remark that if conscious intelligence is to be restricted to beings like ourselves, capable of thinking in verbal images and of carrying out syllogistic reasoning, this classification will deny intelligence in any form, just as surely to chimpanzee and to the human infant as to the crayfish.

In 1858 the Ray Society published a monograph by Huxley on the oceanic Hydrozoa, which embodied results already included in shorter papers read before the Linnean and Royal Societies. In this monograph we find Huxley's most important contribution to our understanding of the anatomy of the Invertebrata. This was an explanation of the structure of Hydrozoa based on the assumption that in every case their bodies were constructed out of tubes composed of two layers of cells, and of two only, an outer and inner. It was Allman, not Huxley, who conferred on these layers the names ectoderm and endoderm, but Allman followed and confirmed Huxley, who had first observed the fact

and recorded it in a paper sent to the Linnean Society in 1847, but not read until 1849. In the monograph which we are at present discussing he takes the bolder step of comparing the outer layer or ectoderm of the hydrozoon polyp to the epidermis of a vertebrate animal, or rather of the vertebrate embryo, and the endoderm to the so-called mucous layer of the vertebrate embryo, which is applied to the yolk and draws nourishment from it. It is not too much to say that all our later knowledge of invertebrate development and anatomy is built on this foundation so well and truly laid by Huxley. Huxley points out that in invertebrates, as in us, the endoderm remains in a comparatively unaltered condition throughout life, whilst the ectoderm undergoes an enormous amount of modification in giving rise to cuticular, sensory, and nervous structures.

In making his generalisation Huxley lays down criteria of what constitute real homology or correspondence between two structures. The first criterion is that two homologous structures must *develop* in the same way from similar parts of the body. The second criterion, which is to be used if a knowledge of development is not available, is that two structures regarded as homologous must be connected with one another by an unbroken series of structures of an intermediate character, each differing from the next by very slight differences. Fundamental unity of plan in the structure of an organism accompanied by wide variations in details was an idea which occupied a central position in Huxley's mind in all his dealings with animal life.

The second great contribution which Huxley made to science in the course of his studies of the Invertebrata was the discussion and definition of what was meant by the terms "variety" and "species." In his monograph on the crayfish he gives brief descriptions of crayfishes found all over the world, and deals with the question as to how the various "kinds" originated. He points out that the word species has two meanings, one morphological and the other physiological. A morphological species, according to him, is simply an assemblage of individuals which agree with one another and differ from the rest of the living world in the sum of their morphological characters. A physiological species, on the other hand, is a group of animals the members of which are capable of fertile union with one another, but not with members of any other group. Huxley also applies the term "physiological species" to the concept of the whole number of individuals supposed to be descended from an ancestor which had originated by an act of special creation. He goes on to say that the great majority of species described in works on systematic zoology are morphological species; that is to say, they are groups of similar animals, which

differ from all previously known animals by some definite character or groups of characters. Of course, as he remarks, the identity of the individuals making up a species is not absolute. Apart from marks indicative of age and sex, children never resemble their parents exactly, but present small and inconstant differences from them, so that to collect together a number of individuals in a species merely means to assert that the differences between them are so small and inconstant that these differences probably lie within the limits of variation.

As contrasted with a species, a "variety" or "race," according to Huxley, is the offspring of an individual in which a marked variation occurs, which is propagated to all its descendants; the variety is thus engendered within the bosom of the species, and, as Huxley says, if nothing were known of its origin it would have a valid claim to be regarded as a true species. A race, however, may be generally discriminated from a species by the circumstance that its distinctive characters are not equally well marked in all the individuals composing it.

Therefore Huxley draws the conclusion that morphological species are merely provisional arrangements of animals indicative of the present state of our knowledge, and that it is impossible to say whether the progress of inquiry into the characters of any group of individuals may prove that what had hitherto been taken for mere varieties were distinct morphological species, or whether, on the contrary, what had hitherto been regarded as distinct morphological species were mere varieties. Huxley illustrates this by what had happened in the case of the European crayfish (*Astacus fluviatilis*). Milne Edwards had regarded all its forms as varieties of a single species, whilst Schrank had divided them into two species, namely, the stone-crayfish (*A. torrentium*) and the "noble" crayfish (*A. nobilis*), distinguished from the stone-crayfish by its deep red claws and its larger size. Huxley is inclined to agree with Schrank, because when both forms were introduced into a "crayfish" farm, they refused to interbreed.

Huxley's estimate of the value of specific determinations has received many confirmations since his time. Great Britain was supposed to rejoice in the possession of one peculiar species of bird, the Scotch "red" grouse, the nearest congener of which was the willow grouse of the Continent. When, however, the red grouse was taken to Norway, in about two generations it became indistinguishable from the willow grouse, and when the willow grouse was brought to Scotland it became changed in the same way into the red grouse. In fact, it is becoming every day clearer that there is a continuous passage from a slightly marked local variety to a well-marked species, and so the question of the origin of species resolves

itself into the question of the origin of these local races or varieties.

Huxley's views on this point read like a curious anticipation of "mutationist" doctrines. As we have seen, he attributes the formation of a variety to the appearance of a single abnormal individual or "sport." This view, we think, is no longer tenable. If by variety we understand a number of progeny artificially reared from a carefully selected pair of parents by man, then Huxley's opinion might be defended; but Darwin was more far-seeing in this respect than Huxley, for he says that he found that every strongly marked variety which he had observed occupied a definite "station" or locality. Now the diagnostic characters which discriminate these "varieties" from one another are widely different from those which distinguish a sport from the fellow-members of its species. In the first case we have to deal with slight evasive peculiarities which affect the form and size of many organs; and these differences, as the example of the willow grouse shows, are almost certainly reactions to changed climate. But in the case of the sport we have a disharmony in the factors which operate in heredity to build up the body; this disharmony is due to the disproportionate weakness of some of the factors, and unless selection is constantly practised, if the offspring are exposed to normal conditions the disharmony will gradually disappear, and with it the characters of the sport. This result is attributed by the modern "geneticist" to reversion or "mutation backwards" (Morgan); it really is recovery from germ-weakness. It is because of its physiological substratum of *damage to the germ* that the characters of a "sport" are so unequally developed in its progeny, as Huxley justly remarks.

Huxley's "Crayfish" not only summarised all that was previously known of the anatomy of this animal but also contains his own original observations; and it is to this book that we must go for the only detailed and clear account of the somewhat complicated internal or "endophragmal" skeleton. This skeleton is made up of the various "apodemes" or folds of inturned ectoderm which give support to the various muscles and perform the function fulfilled by bones in the vertebrate skeleton.

Huxley was not an embryologist, but his deep feeling for fundamental similarities of structure led him to make some astonishingly correct embryological guesses, which might almost be termed embryological prophecies. Thus he surmises that the formation of the endoderm by so-called "delamination" may be a modification of the older method of its formation by emboly or invagination; that the formation of the perivisceral cavity by pouches given off from the gut, such as occurs in Chætognatha, Echinodermata, and Brachio-

poda, may become modified so as to take the form of solid masses of mesoderm cells growing out from the gut, as is observed in the development of Arthropoda and Annelida. Both these views have received abundant confirmation in subsequent embryological research.

If we ask ourselves, in conclusion, what part of Huxley's work on the Invertebrata has endured and what part has proved to be of transitory value, we may answer that, in almost every case where discoveries were to be made by dissection and macroscopic observation, he has proved to be right, but that where microscopic investigation was necessary he was often wrong. This is not to be wondered at when we remember the extraordinary crudity of the means of preserving specimens and of cutting sections which were available in his day. Thus he compares the pallial folds of the cephalopod embryo to the trochal ridges of the gastropod. He regards the annelid *Polygordius* as a transitional form between Turbellaria and Polychæta, and Porifera as belonging to the same fundamental group as the Coelenterata. The blood-system of lamellibranchs is said to communicate with the exterior by pores in the foot. Huxley asserts that the ovaries of parthenogenetic females amongst Insecta are fundamentally different from the ovaries of sexual females; he denies that the parthenogenetic ova are true ova;

he regards all the parthenogenetically produced insects as portions of one individual; in a word, he confuses primary asexual reproduction by budding or fission with secondary asexual reproduction by parthenogenesis.

On the other hand, Huxley examined *Peripatus*, and pronounced it to be a true arthropod, allied to the suctorial Myriapoda, at a time when many of his contemporaries referred it to the worms or the Mollusca; he described most accurately the peculiar process of budding in the Tunicata; he refused to accept Agassiz's and Cuvier's view of the affinities of the Echinodermata with the Coelenterata, a view which was expressed by relegating them both to a class Radiata, nor was he any more friendly to Haeckel's conception of an echinoderm as a budding worm, in which all the buds radiated from a centre. In view of the extraordinary metamorphoses of echinoderms, which start as bilaterally symmetrical animals and attain radial symmetry round an axis cutting the principal axis of the larva at an oblique angle, Huxley regarded them as a completely isolated group. Finally, we may say that no one can read the "Anatomy of Invertebrated Animals" without receiving the impression that he is being brought into contact with a great growing science, full of the most interesting and still unsettled questions, with promise of rich reward to the future researcher.

### Processes of Life and Mind.

By Prof. C. LLOYD MORGAN, F.R.S.

IN Huxley's life-work there is a combination of the exact methods of inquiry which characterise the man of science with the breadth of interest which, in practice, distinguishes the man of affairs, and, in thought, betokens the philosopher. He claimed that all behaviour and conduct fell within his province as biologist, and that this should include all mental events which may accompany the actions of living beings.

From first to last Huxley stood not only for one method of scientific interpretation, but also for one order of Nature. Within that one order there are events that we call physical; there are events that we may call vital—those which occur only in living organisms; and there are events that we call mental—those with which we, and, as we infer, certain other living beings, are acquainted in diverse modes of feeling and under diverse forms of objective reference. If these be found in the Nature we seek to interpret, they should be loyally accepted as inherent in that Nature, and should be dealt with in accordance with the accredited methods of scientific policy. In brief, the outcome for Huxley was this: (1) All vital events in living organisms have a physical basis; that is, they occur only when

certain physical events are also in being; and (2) mental events occur only when certain specialised physiological events are also in being.

This does not imply, under (1), that vital events are physical only. They are distinctively physiological in that there are modes of action of a specific kind. There are biological as contrasted with abiological properties. None the less, they are physical also. Huxley could find no evidence of "connecting links" between biological and abiological events. "Those," he said, "who take a monistic view of the physical world may fairly hold abiogenesis as a pious opinion, supported by analogy and defended by our ignorance. But as matters now stand (1886) . . . no claim to biological nationality is valid except birth." He was strict in his demand for evidence. Whether, in the light of such evidence as has since been adduced under new methods of scientific approach, he would soften the expression "defended by our ignorance," one cannot say.

Nor does the second clause of the above summary statement imply that mental events are physiological only. There is in them something new and specific.

None the less Huxley contended that, on the evidence, they have no being apart from certain physiological changes in a differentiated region of the central nervous system. There is a neural basis of mind, as there is a physical basis of life.

Cardinal throughout is emphasis on one order of Nature. There is no extra-natural insertion from a disparate order of being. This note was struck firmly and clearly in "The Physical Basis of Life" (1868). Even there the story of mind as accompanying the story of life, when it reaches a high level along certain lines of advance, was touched on in the concluding protest that he was no materialist, but, on the contrary, believed materialism "to involve grave philosophical error." He did, however, urge in effect that the story of life should be told in terms of physical and physiological concepts, whether they be accompanied by "states of consciousness" or not. He claimed "first, that the order of Nature is ascertainable to an extent which is practically unlimited; and secondly, that our volition counts for something as a condition of the course of events"—adding in a footnote (1892), "or, to speak more accurately, the physiological state of which volition is the expression."

Two years later the physical basis of life and the neural basis of mind were considered in the light of Descartes' "Discourse"; and, at the Belfast meeting of the British Association (1874), in the evening address on "Animals as Automata," he took up in further detail the accompanying story of mind, with stress on the hypothesis that animals, and men too, are conscious automata.

For many then, and now, "conscious automata" involves a so-called contradiction in terms. If conscious, it is said, not automata; if automata, not conscious. Any such contradiction depends, of course, on the definition of the terms. No doubt they may be so defined that each is flatly contradictory of the other. Clearly, then, Huxley did not so define them.

One should try to grasp the interpretation of mind that Huxley was concerned to advocate. Whether the oft-quoted steam-whistle analogy and the statement that consciousness answers to the sound which a bell gives out when it is struck, serve their purpose well, is a matter of opinion. It may be said: Since no one attributes volition to the engine or feeling to the bell, why not consider rather the procedure of some one who is crossing the railway-lines, or is awaiting the summons to lunch? If we do so, then Huxley contends that it is not a "state of consciousness," volition or other, that is causally effective, but certain physiological action in the brain consequent on the stimulation of the sensory organ. It is in this sense that we are bidden, in 1892, to understand the earlier statement

"that our volition counts for something as a condition of the course of events." Nor is this an after-thought. It is implicit in his thesis from first to last.

In the Berkeley Essays of 1871 and 1879, in dealing with St. George Mivart's criticism of "The Descent of Man" in the former year, and in the "Hume" of 1874, Huxley unfolded his reading of the metaphysics of sensation and showed the trend of his method of psychological analysis. One must remember that he wrote some half-century ago; one has also to fill in the implications of certain statements that he did not fully expand.

"States of consciousness"—this expression was then current—were regarded by Huxley as accompanying certain physiological changes in the brain. But consciousness as accompaniment in feeling—in enjoyment, as some now say—is only part of the story of mind. There is also that reference to something objective which Huxley spoke of as "extradition." In tactile sensation—more strictly tactile perception—the touch-datum concomitant with physiological events in the "sensorium" is "referred outwards to the point touched, and seems to exist there." In using a walking-stick "the tactile sensation, which is a state of our own consciousness, is unhesitatingly referred to the end of the stick; and yet no one will say that it *is* there." Huxley clearly indicates his view that such localisation is more than sensation only, since it depends, he says, on "ideas of relation." There is distinctively cognitive reference. In vision "every *visibile* . . . is referred outwards, in the general direction of the pencil of light by which it is rendered visible, just as, in the experiment with the stick, the *tangibile* is referred outwards to the end of the stick."

Although Huxley did not, in so many words, distinguish accompaniment in feeling from the going forth of reference under "extradition," it is implied throughout. When I asked him, in 1883, how he accounted for this extradition, the purport of his reply was: "There it is. It is given in our experience. We must take natural processes as we find them, and trace their development."

In cognitive reference, under the highly developed form which has been reached in adult human folk, there is clearly a valid sense in which it may be said that "what" is referred—the *tangibile* or the *visibile*—is "where" it is referred, at the stick-end or in Sirius. But it is so referred from the sensorium. "Here" is the source of reference to Sirius; "there"—if we acknowledge an external world—is the source of physical influence on the retina, and, through the intervention of a wave of action in the nerves, on the sensorium. As Huxley put it, in effect, we may ascend the hill of vision by two paths on opposite sides. One

path follows the influence from Sirius; the other path retraces the reference that goes forth to Sirius. One is material, the other is mental, each after its kind in the duality of Nature. Take which you will, they meet at the summit. Both are the outcome of a long process of evolution; so also is such accord as obtains.

Though, as physiologist, Huxley gave primacy to the material or physical path, as idealist he gave primacy to the path of mental reference. What know we of Sirius as a purely material existent—apart from reference in perception or under reflective thought? The light-waves received by the retina are separated from the brain-events which are concomitant with reference by many intervenient events of a specialised physiological character. That is so with all that is objective under percipient reference. Are we justified, then, on the available evidence, in saying more than that what is objective under reference is a world of mental symbolism, that, in Descartes' words, enables us "to walk sure-footedly in this life"? Huxley thought not. But does this imply that mental symbolism counts for nothing in the course of events?

Huxley's statements would have been

clearer (if one may dare to say so) had he more emphatically distinguished cognitive reference from concomitant feeling—both included in "states of consciousness." But his contention comes to this: Without denying "that there may be a real something which is the cause of all our impressions," we may assert "that sensations, though not likenesses, are symbols of that something." It is in the concept of reference—or that of extradition, as he put it—and in the corollary of phenomenal symbolism that Huxley was idealist. In this sense

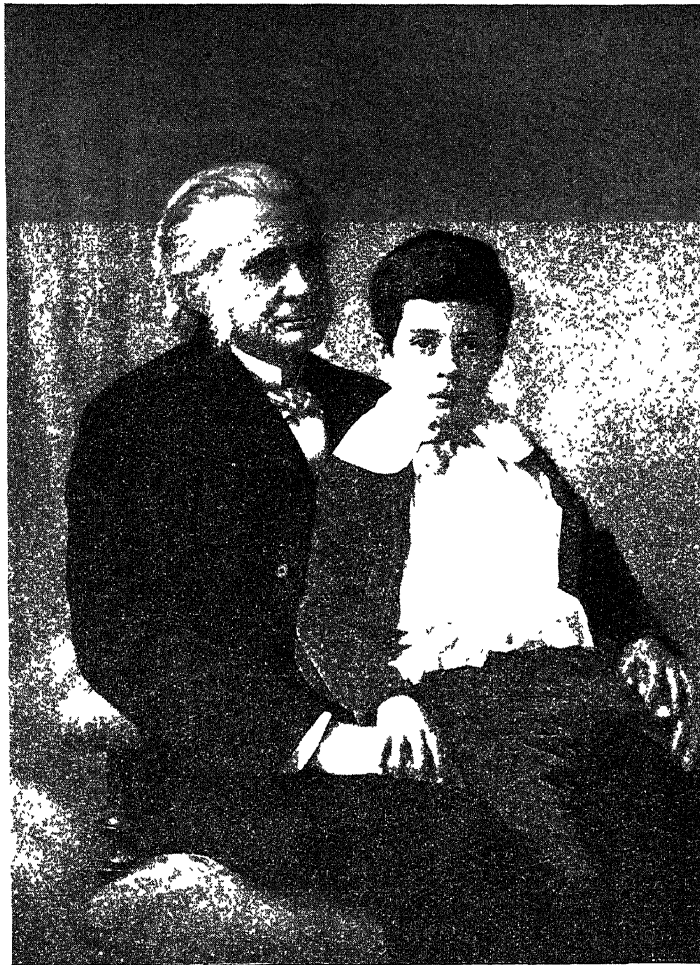
"the more completely the materialist [that is, the physiological] position is admitted, the easier it is to show that the idealist position is unassailable, if the idealist confines himself within the limits of positive knowledge."

Strike out the concept of objective reference, leave in only accompaniment in feeling or enjoyment, and Huxley's thesis is shorn of full half of its significance. Seeing that the word "sensation" is ambiguous in

that it may mean (a) the enjoyment which accompanies sensing, or (b) that which is sensed under cognitive reference, it does no injustice to Huxley's thought if the words in italics be substituted for "sensation" and "state of consciousness" in the following passage: "The great fact insisted on by Descartes, that no likeness of external things is, or can be, transmitted to the mind by the sensory organs; on the contrary that, between the external cause and the centre from which mental reference goes forth, there is interposed a mode of motion of nervous matter, of which the object of reference is no likeness, but a mere symbol, is of the profoundest importance" (1874).

Such was Huxley's

concept of symbolic] reference. Since his death it has been subjected to New Realist criticism, with emphasis on direct apprehension on the part of the mind. Vision, audition, and other modes of sensory acquaintance do not, it is said, afford only a highly evolved symbolism which enables us to walk sure-footedly; they reveal or disclose the very nature of the objective world, with its colours, sounds, and odours, perhaps also its beauty, quite independently of those instruments of apprehension which we call the



1895.

T. H. HUXLEY WITH HIS GRANDSON JULIAN.

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organs of sense. What Huxley's attitude towards the sensum-theory would have been one cannot say.

One may, however, surmise that his emphasis on one order of Nature, and his insistence on positive evidence of the scientific kind, would have remained unchanged. In the light of fresh evidence he might, were he still with us, concede that the evolutionary step from the cognitive reference of even the highest apes to reflective reference in human folk was greater than he allowed when he criticised Mivart and Wallace, and such as in some measure to justify on empirical grounds Descartes' distinction between the animal and the human mind. On the other hand, he might urge that the fuller knowledge we now have of the comparative anatomy and physiology of the brain still endorses his cardinal tenets—one order of Nature, one evolutionary process.

That mind is not an extra-natural insertion invoked to explain certain facts, said to be otherwise inexplicable, but is the outcome of natural advance, was the burden of his contention throughout. The highest attainments of reflective thought, the richest modes of symbolism in evolutionary ethics, imply a physiological basis, and without this would be non-existent.

In Huxley's day the locus of discussion was in respect of reflective thought. Now it extends downwards to the very basis of life. Not only the volitional procedure of man, but his embryonic development, and the whole course of organic evolution, is in some quarters interpreted in terms of possession by an extra-natural

entity that uses physical events in its endeavour to reach ends in some measure foreseen. What Huxley might have said on this head is a matter of surmise. But, apart from surmise, one can assert that it is not in accordance with the teaching we owe to him, or with the method of interpretation of those biologists who maintain what may be called the Huxley tradition.

The issue thus raised in new form since Huxley's death is one that primarily affects his philosophical opinions. It has, however, been said that, if the issue be decided in favour of what claims to be the new biology, Huxley's interpretation of life-process stands condemned. That is not so. Within his special province of inquiry he was concerned to discover new facts and the plan of natural events of which these facts afford instances. Surveying the whole field of Nature, he sought to formulate a comprehensive schema as the plan of all natural plans. In this task, to which he devoted great power with singular honesty of purpose, he believed that mythological concepts are worthless, and said so in language sufficiently clear and emphatic.

One has, therefore, to distinguish his positive contributions to the sum of human knowledge from his negative attitude in respect to the value of what he regarded as mythical. His positive work, like all good work, stands secure. It is for those who advocate mythological explanation to show in what manner it is of service in "improving natural knowledge."

### Huxley as Teacher.

By Prof. PATRICK GEDDES.

LOOKING back to young days, a full half-century ago and more, I vividly remember how Huxley's influence first came upon me—and indeed to an extent mainly determinant for after-life, far beyond all other teachers, my father alone excepted; and, like him too, for substantial following, albeit necessarily also in each case with some elements of rebound. Hence a personal opening and treatment may be clearest. I had been an eager field-naturalist from childhood, botanist and gardener too, mineralogist and rock-work builder; and at school had naturally revolted from its too conventional classics, and taken to the modern side. Hence purpose towards science, though in what specific line I could not clearly say, amid its many and varied attractions. During school days my wise father had given me a museum shanty, and next built me an outhouse laboratory and workshop. Then on leaving school, as I could not yet define my college ambitions, he encouraged me to various trials, as of chemistry (with some teaching from the nearest analyst), of mineralogy and

botany, with a little geology too, and of the rudiments of zoology and physiology. The whole, too, with the summers free for varied roaming and voracious reading, by turns and together; to which he added also a brief but salutary and steadying experience of office and of workshop, as well as a period at the art school; and all this fundamentally upon his theory of self-education, though with reference and help on various sides as needed—a method I had enthusiastically adopted, and hold by still. Hence I felt happier than my old school-fellows, by this time fully in the regular university or other mill; and I still feel fortunate in having been given these adolescent years, in freedom from all routine fixity and examination-pressure, and with studies pursued for their interest alone.

After nearly three years of this phase, my father and I agreed that it was now full time to be settling for university choice and course; and again he left these difficult selections to me. As botanical interests had by this time grown paramount, I first turned to Edin-

burgh; but the briefest of contacts with the too formalistic treatment which was then paramount there, disillusioned me, even to immediate revolt; and this all the more because I was fascinated by Huxley's "Lay Sermons," which were then widely spreading abroad a vision of biology on very different lines, and at deeper levels. Hence came quickly the solution of my difficulty—here is the master to whom I must go. My parents were alarmed, and naturally enough; for my father was an elder in the Free Kirk, and my mother had long hoped to see me in its pulpit. Still, they met the situation cordially and well; in faith too—which increased my respect alike for them and it: so off to Huxley accordingly in 1874.

I had, however, a disappointment; for at the first brief interview with the great man he sentenced me to another preliminary year of chemistry, physics, and geology, before I should come to him. As I next got no credit from Dr. Frankland or others for my years of unofficial studies, but had to begin all over again, this year gave little more than revisal of what I knew already, save that Ramsay's geology was a real stimulus. However, I had the wide resources of London—museums, collections and libraries, galleries and theatres too, thus continuing the self-education habit.

The good time at length came: so I had two years of Huxley. His laboratory was open all day and every day throughout both winter and summer terms, though his lectures—always good measure over the hour (once nearly up to two hours, which left us exhausted!)—were in winter only. Never, of course, had I heard such lectures; or indeed since. Nothing could be clearer than his demonstrations of his well-chosen specimens, always sufficient for his exposition and argument, yet never in redundancy; for his essential method lay in the educative value of the type-series and collection for the student, as compared with the redundant and bewildering wealth of the great museums. (Hence indeed one of his best-known gibes: that from the British Museum the London visitor mainly acquired sore feet, a headache, and an increase of his already amply sufficient thirst for beer!) His lucid explanations went on with the gradual and creative up-building of first-rate blackboard drawings in colour; which he left for us to incorporate, after lecture, on the plain page of our note-books opposite the written page. His paper diagrams too were also of the best: not only the well-elaborated diagrams by G. B. Howes, who had already been for some time thus occupied, but also a good many from his own hand. Among these too there sometimes appeared a touch of the dry humour which now and then twinkled in the lecture: thus I particularly remember our delight over a fine sheet of half-a-dozen

heads of leading genera of Primates, in which the profiles of the big-nosed Tyndall, the bearded Darwin, the bright-maned Duke of Argyll, as well as of himself, were unmistakably suggested upon the simian level.

For his laboratory too his claim was to be "a disciple of Mr. Squeers:—W-i-n-d-e-r, window: go and clean it! O-n-y-o-n:—onion—go and weed it!" for after morning lecture we had the whole day at dissection under his excellent demonstrator, T. Jeffery Parker, and with a daily visit from himself. For he had told us at the outset, "If you are to learn this subject (or I believe any other) you must apprentice yourself to regular all-time work at it, just as you would for any craft or trade. And if you can thus spend even a single winter term, these five months, you will then know something about biology which you won't forget all your life." I was soon convinced that he was right, and indeed remain so; so I have tried to apply this, so far as might be, in my own teaching life; and must we not increasingly come to some such concentration and thoroughness for all subjects? First the anatomist, and then the chemist, have longest thus been teaching; but the inroads of new subjects have too much made the student's day one of hour-fragments, like the school ones. But schools too are coming to longer periods; and so must university instruction also. Broader day-sections need not go on so long, and they leave more permanent results: so Huxley here, as in other respects, knew his work as pioneering educator.

The practical class, with its first careful introduction to dissection and histology of his chosen type-series, from *Amœba* onwards, has long been too well known to need description here; but its in these days new and innovatory influence, as accompanying the corresponding lectures, and all as a broad introduction to later and fuller studies in botany and zoology—is even yet far from exhausted; nor can it ever be. For here was the very first of laboratories, as also of lectures truly and broadly biological; and thus with our initiation to a not only elementary, but elemental, understanding of the various viewpoints of the science. Though necessarily mainly anatomical and histological, it was consistently and lucidly physiological too. Taxonomy was not stressed, but clearly indicated; and the larger physiology of Nature—ecology—early opened to us in its colours and perspectives. His introduction to embryology, as at once so protean yet so deeply orderly, was never to be forgotten; and his presentments of the palæontological record—as for reptile and bird, and above all for his favourite battle-steeds, the horse-kind—transmitted to us his clear and concrete views of their gradual evolution. His pupils could not but henceforth keep something of these varied outlooks, and in following their chosen one could no longer lose sight of

others. Thus one's latest publication, fifty years after—that of a little "Biology," with Prof. J. Arthur Thomson—is an endeavour to continue the like comprehensive introduction to the science.

Through all this breadth of presentation the interest of morphology stood out clearest and central to all: witness his quiet but unmistakable intellectual pleasure in lucidly setting before us the unity, yet variety, of each related series of organic forms, as for his especially beloved crayfish and lobster. After that, who could not but understand Goethe's term "Morphologie," and this not only as a culmination of his scientific work, but as perhaps the very greatest of his poems? Yet his interest in the various working of homologous parts was intense; indeed I remember him once sitting down beside me and, after giving me an illuminating explanation of my dissection, saying, half to himself, "You see, I should have been an engineer!"

I soon became a fairly good dissector; indeed, with Parker's care and Howes' example, we could not but do our best. By and by I grew fond of setting myself tests of skill, like dissecting out more neatly the growing point of *Chara*, the mouth-parts of *Cyclops*, and what not. So I was one day greatly honoured by having a specimen kept for the museum, and with encouragement to go on making more. I had several months of this, as the only second-year student; and thus, though quite junior of course to Parker and to Howes, I became something of a real assistant. One day, said Huxley, "You have been at this now long enough: it is time you started on a research of your own. Choose any subject you like, on which I can give you the material; and go ahead!" Next day he asked—"Well, what subject have you chosen?" I confessed I had not found one. "Well, well, think it over for a day or two!" But, alas, I remained as I was; for if his teaching had any fault, it was only too clear! His exposition of an animal, a part, a structure, was so perfect that it seemed to us finished, and leaving nothing to be said by him, or asked by us. "Well, well, I'll give you a subject to begin with!" So he got a whelk and a limpet out of pickle, and explained to me his view of the general mechanism of their horny tongue-cover, the "radula," as a flexible file, drawn to and fro by attached muscles, upon its cushion or "odontophore." So as he had never found time to work out this mechanism carefully, and throughout a series, I was set to this.

I worked away, and of course on his hypothesis; but gradually doubt began to arise. At first I was convinced I must be wrong; and so went over my dissections anew, day by day, and with fresh types also. At length, however, when he asked me, "Well, have you worked that out?" I ventured, very timidly of

course, to express my difficulty. "No, no," said he; "look at that and that;—try again!" and so went off. Next day, "Well, have you got it clear?" "Very sorry," said I; "but it seems to me that the thing works just as a licking with the whole odontophore, and not a pulling to and fro of the radula." "Well, well, let me see." So I showed him the set of dissections I had prepared. He looked through them keenly for a minute or two—which seemed to me long! Then suddenly he jumped up, gave me a great slap on the back, and said, "'Pon my word, you're right! You've got me! I was wrong! Capital! I must publish this for you!" So he made me draw three plates, and write my paper, which he then presented to the Zoological Society, for its Transactions, and as a correction of a bit of his own work by a pupil. I had no vanity in the matter, for I had merely spent weeks over what he had probably only given an hour to; but his splendid candour, and real pleasure in getting a point of correction, was the very best of encouragements; since which I never again had difficulty in seeing far more problems for research than could be undertaken.

I searched Huxley's books and papers to see if there were any other little point I might try again to catch him on, but failed completely: so the upshot was more respect and admiration for him than ever, and alike as anatomist and as man. After that, too, his kindly interest increased. He found me a demonstratorship under Thiselton-Dyer and Vines for a vacation course, then discussed with Michael Foster and Francis Balfour their opening a career for me at Cambridge, whence a delightful stay with the latter of these. When I decided not to go on at Cambridge, but to Continental schools, he said "wait a bit"; and so put me up for the Sharpey physiological scholarship at University College; which carried with it the alternative of assisting Burdon Sanderson or of demonstrating for Schafer, of which I chose the latter. At the close of my first winter there I had a sharp illness, for which an Easter vacation change was prescribed: so said Huxley, "Go to Roscoff; I'll give you an introduction to my friend Lacaze-Duthiers." Hence to this I owed the first of the two or three delightful mind-stirrings of convalescence which have been epochs of my personal life. Nor was this his last encouragement and kindness.

All this, I hope, will not be misunderstood as self-centred but as illustrations of how the true teacher, even beyond his regular course, seeks to help his students on, and towards such continued productivity as they may be capable of. Since then I have wandered far, and into various other fields; but none the less it is but just as well as pleasant to record—along with appreciation of the biological thinker and educator,

the truly open-minded investigator—one's lifelong gratitude to the kindly and paternal "old man!"

What a pity that Huxley had never the great university position for which he was so supremely fitted! What a school he would have formed! Of course, as it was, his teaching was not lost, though his audience was too small—and that too much of mining students on one hand, and of science teachers in training on the other, to each of whom his class was but one of those to be gone through for their professional needs, respectively palæontological or pedagogic. Still, besides Jeffery Parker and Howes—of whom the former did well as professor of zoology in Dunedin, and the latter as his successor—as also Prof. Newton Parker of Cardiff, I remember among my fellow-students others who became biologists. First of all, of course, Lloyd Morgan; also Angelo Heilprin, later a notable American faunologist; and my especial friend, Dr. Angelo Andres, later of Naples and Milan. Of contemporaries otherwise educatively aided, I must cite William Hewitt, who after a fertile career of organising science teaching for Liverpool has lately been continuing Huxley's earliest and pioneering "Physiography" in his admirable "Survey of the Wirral District." Again, Ameer-Ali, since eminent as the essential founder of Aligarh University, the leading Mohammedan institution of learning

in India, and now, though a busy Judge of Appeal for the Privy Council in London, has passed on his scientific interests to his son. Most unusual of us all, in his approach and interest, was the Rev. E. F. Russell, curate of St. Alban's, Holborn; a fine spirit, who came partly to learn the needful biology towards better medical guidance of his poor parishioners, but above all as an open-minded theologian, determined to get some clear understanding of the evolution doctrine and its bearings on his faith, and this by giving a fair hearing to its prime exponent.

There must have been others, even in my years, and thus doubtless a good many throughout his long teaching life, who in their various ways have owed much to Huxley; as notably H. G. Wells and C. V. Boys; and it would be of interest if each would write his own personal experience as I have mine. But doubtless the comparative fewness, after all, of direct pupils may have nerved him the more for his wide and varied literary as well as scientific output, of which it is not my province here to speak; as also to those admirable lectures to great audiences of working men, which made him the foremost of pioneers of what is now the vast University Extension movement; of which the students thus also owe more than they know to Huxley as teacher.

### Huxley's Message in Education.

By Prof. H. E. ARMSTRONG, F.R.S.

"Above the altar or what serves for one is a bust of Truth: it is in wax and unfinished."—Sir ARTHUR KEITH.

I FIRST heard Huxley, little short of sixty years ago, when, as a young student of chemistry at the Royal College in Oxford Street, I tasted his lectures at Jermyn Street—in days before a single educational brick was laid at South Kensington. My mind was soon made up that he was above me and his subject one that would not serve my purpose, even if not beyond my attainment; the lectures were too didactic, the treatment too special and detailed for my taste. We handled nothing in those days: Thiselton-Dyer, Michael Foster and Ray Lankester were not yet his henchmen. Zoology was then a purely descriptive science and the real Huxley—the combative philosopher and logician—was in no way apparent: he gave us results but no method. As a lecturer, apart from his fluency, he made no special impression upon me, but his blackboard drawings were fascinating. I did not come into personal touch with him until 1884–85, when I was translated to South Kensington, one of the small band charged with the working out of a scheme which he had done much to promote. He took no special interest in us, however: to me, indeed, he

always seemed distant, if not unsympathetic. Doubtless his mind was over-full at the time and his health bad. His outward manner was the more disappointing, as, from the beginning of my career as a teacher, I had been greatly influenced by his writings and was consciously anxious to tread in his footsteps. Few probably now realise how great his public reputation then was—how great a service he had rendered to education by his addresses and writings during the previous thirty years. Excepting Liebig, perhaps, no one had done so much to make scientific study known and respected. Liebig, however, was an experimental philosopher: we owe the introduction of the laboratory method to him before all others. Huxley, in the main, was outwardly didactic, with a definite tendency to pontificate: at heart he was ever the inquirer. No other interpretation can be put upon the words he used in a letter to the divine, Charles Kingsley, in 1860:

"Science seems to me to teach in the highest and strongest manner the great truth which is embodied in the Christian conception of entire surrender to the will of God. Sit down before fact as a little child, be prepared to give up every preconceived notion, follow humbly wherever and to whatever abysses nature leads or you shall learn nothing."

We have here the ruling principle of Huxley's life in a single sentence. Though a biologist by profession, he had the physicist's, not the naturalist's, outlook of mind and love of exactitude. A comparative anatomist of the very first rank, he was also an anatomist of society: still, his tendency as a teacher was mainly descriptive. Take, for example, his text-book of "Physiology"

—a story delightfully set out but none the less a book of mere fact, without any attempt to display the method of discovery — which is the background of our modern progress. To my thinking, the treatment of the subject in no way fits the doctrine he himself laid down in his after-dinner speech in 1869, the year in which the lectures incorporated in the book were delivered, in expressing his "firm conviction that a complete and thorough scientific culture ought to be introduced into all schools":

"By this, however, I do not mean that every schoolboy should be taught everything in science. That would be a very absurd thing to conceive and a very mischievous thing to attempt. What I mean is, that no boy nor girl should leave school without possessing a grasp of the general character of science and without having been disciplined, more or less, in the methods of all sciences: so that, when turned into the world to make their own way, they shall be prepared to face scientific problems, not by knowing at once the conditions of every problem or by being able at once to

solve it but by being familiar with the general current of scientific thought and by being able to apply the methods of science in the proper way when they have acquainted themselves with the conditions of the special problem."

What those methods were, in his opinion, is most clearly stated in the lecture he gave, in the autumn of

1880, on "The Method of Zadig" ("Collected Essays," vol. 4). He knew his mind at an early age.

"Science is, I believe, nothing but *trained and organised common sense*, differing from the latter only as a veteran differs from a raw recruit. . . . The vast results obtained by science are won by no mystic faculties, no mental processes, other than those which are practised by every one of us in the humblest and meanest affairs of life."

These quotations are from a lecture delivered in St. Martin's Hall in 1854, when he was only twenty-four years old. It is obvious, from the remarks he makes in the Preface

to the third volume of the "Collected Essays" in which the lecture is printed, that he was himself of the opinion that he had displayed the foundations of his belief in this early essay.

Where are we in comparison with where Huxley was seventy-five years ago? By "science" he meant what to-day is called scientific method—a term which has but a single and a clear meaning independent of



STATUE IN THE CENTRAL HALL OF THE BRITISH MUSEUM (NATURAL HISTORY)  
BY E. ONSLOW FORD, R.A.

The statue was unveiled on April 28, 1900, by H.R.H. the Prince of Wales (King Edward VII.).

subject. The word "science" has now but a vague meaning at best and is too general in its implications. There is a growing tendency to narrow its application. To Huxley, I believe, it ever meant wisdom, especially in natural knowledge—never mere knowledge. Hence it was that he could advocate the cultural value of "science" in education. This is implied in the title of the 1854 lecture "On the Educational Value of the Natural History Sciences."

In 1868, in the essay "A Liberal Education and Where to Find It," Huxley says :

"What I mean by Education is learning the rules of this mighty game [of life]. In other words, Education is the instruction of the intellect in the laws of Nature, under which name I include not merely things and their forces but men and their ways ; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws. For me, education means neither more nor less than this."

Speaking in 1869, as an advocate of "the introduction of scientific training into the general education of the country," he specially advocated

"the introduction of physical science into elementary education, both because it may be shown to be indispensable to the complete training of the human mind and as a means of getting on."

In 1880, at the opening of the Mason College, Birmingham, the forerunner of the present University, Huxley delivered an address on "Science and Culture," in which he advocated

"scientific training" as the means of giving culture. "Culture," he said, "certainly means something quite different from learning or technical skill. It implies the possession of an ideal and the habit of critically estimating the value of things by comparison with a theoretic standard. Perfect culture should supply a complete theory of life, based upon a clear knowledge alike of its possibilities and of its limitations."

Literature alone could not supply this knowledge.

"I should say that an army, without weapons of precision and with no particular base of operations, might more hopefully enter upon a campaign on the Rhine, than a man, devoid of a knowledge of what physical science has done in the last century, upon a criticism of life."

I heard the Mason College address in 1880. What has happened in the interval ? What has Birmingham done, what have the schools of university rank elsewhere done, to give "science" cultural value ? Speaking at Birmingham, in the University, only in October last, asking this question, I could only say "that Huxley's message had been delivered to no purpose !" No student to-day seeks training in science to serve cultural ends but merely to "get-on in life," as pro-

fessional training. What is far worse, it is not taught either in school or university as a cultural subject. It is not an integral part of the educational system, commensurate in the public eye with literary training and even more essential. On the technical side progress is astounding but the world is lop-sided in consequence ; the public is in no way trained either to appreciate, let alone use, scientific method or to grasp the power of the forces it is using, which may easily be turned against it to its undoing. We may well take heed of the bann put upon Darwin recently in several of the American States.<sup>1</sup>

Herbert Spencer, Huxley and their school over-rated man's educability. They seem not to have grasped the fact that a weapon which is so novel and so all-powerful cannot and does not appeal to the vulgar mind. The use of a tool can only be taught by those who have learnt to use it : unfortunately, only the very few have command of true scientific method.

Huxley, probably, was a prophet delivering a message the meaning of which he had not himself fully grasped. Overwhelmed by the victories of innate genius, like Herbert Spencer, he jumped to the conclusion that genius could be imitated. While saying ("Mr. Darwin's Critics") that "Ecclesiasticism in science is only unfaithfulness to truth," he overlooked man's innate tendency to worship ecclesiasticism, pure and simple. Examinations make it so. To-day physical doctrine is laid down as something absolute—not as tentative. No cleric was ever more absolute than is the modern cosmic physicist. *Genesis* is not in it with a school text-book of chemistry. There is no sitting down before facts—facts are just used as brick-bats for the poor boy to catch and throw back if he can.

If Huxley had put into his lectures on science *the method* which he used in his discussions with Mr. Gladstone and Dr. Wace, the position might have been made a stronger one. He was judicial and scientific when disputing—didactic when talking of the value of science. He was never, in fact, a direct teacher of scientific method, though, by implication, ever its greatest advocate. He thus gave proof, as we all do, that the mind is compartmented and that the compartments are not necessarily interlocked—indeed, often without means of intercommunication and mutual control.

If Huxley be read with the limitations I have ven-

<sup>1</sup> More and more, science is in the service of Mammon : it is mainly worshipped as a means to "get on," not as being of the spirit and the one sure hope of a lasting religion. This is strikingly illustrated by the selected School Prize Essays, written in a contest, in which 500,000 high school pupils took part, instigated by the American Chemical Society in 1923-24, published recently by the Society. The young essayists all dwell enthusiastically upon the material advantages to be derived from chemistry. No word is said of its method or of the fascinations of its disclosures—not a word to show that the spirit of science has found entry into the school. This too in a country which claims to be a land of ideals. Several books were circulated in the schools—among them "The Life of Pasteur": the great lesson to be learnt from this seems to have passed unnoticed.

tured to place upon his statements, he is infinitely inspiring. We have, more especially, to recognise that we have not yet even attempted to do what he urged should be done; that as yet we have in no proper way interpreted the message which he delivered, though in some degree unwittingly. If we will do so, we may yet achieve his aspirations. We can only do so, however, by recognising, each and all, our own great individual limitations and organising to overcome these. Science is, as Huxley said, *organised* common sense. We have yet to make the attempt to *organise* the considered and judicial use of our knowledge in the interests of truth alone: on no other terms can science be made a moral force.

Progress in organisation is of all things the most difficult to secure—in Great Britain particularly. We have only to take Huxley's plea for the reform of medical education made in 1870. Medicine to-day is in a far worse plight than it was then—the burden of fact laid upon students is ever increasing and one that is impossible for them to bear. Surgery, like all technical trades admitting of advance through experiment, has made the most marvellous progress; apart from what chemists have done for it, the cognate subject medicine can count little to its credit. Scientific method is neither used nor taught in the early stages of the medical student's career: he is eternally crammed into stupidity. The advice given by Huxley in 1870 and again in 1880 and 1881 still awaits consideration: the medical profession will greatly fail in its duty if it do not soon put its house in order, more or less in accordance with his recommendations. As I began my career in 1870 by attempting to teach a little chemistry to medical students and have often discussed the problem of their education, I feel that it is about time that we recognise that, at least in medicine, Huxley's advice should no longer wait upon adoption. Medicine is likely to be more and more a branch of applied chemistry and it is intolerable that its practitioners should be so entirely without *chemical feeling* as they are.

Huxley was of opinion "that stupidity, in nine cases out of ten, *fit, non nascitur* and is developed by a long process of parental and pedagogic repression of the natural intellectual appetites accompanied by a persistent attempt to create artificial ones for food which is not only tasteless but essentially indigestible."

Undoubtedly there is truth in this. I was once whole-heartedly of the same opinion but bitter experience, gained in the attempt to overcome stupidity, has convinced me that we should be nearer the truth if we were to substitute one for Huxley's nine, perhaps. I believe, however, that far more can be done to raise the general average: that by aiming far lower we

shall reach a higher level. Education, in its present form, started in the monastery: the system is still monastic—we have to make it worldly. There is a subtle influence, if not conspiracy, at work depressing the schools, the educational system being such that a particular type of mentality is selected from the community for its service: the literary type, an impractical, unprogressive type. The teachers are learners rather than doers—with few exceptions they do not in the least understand how knowledge is won and used. The professor of education has been but a talker: he has seldom been a doer in the subjects he presumes to teach. As the business of the world is to do rather than to learn, the selection made seems to be a wrong one.

We have spent fifty odd years in making a great experiment. Most valuable information has been won but not the desired result. The question is, Can we utilise our experience and extend the inquiry on the practical side? The quality of teacher the experiment will need is rare: herein lies our difficulty. The task is one of endless difficulty: herein lies our opportunity. Huxley is at hand, telling us that we must not shirk it. He, at least, has stated the conditions of the problem: in days to come, if our civilisation survive, his claim to rank among the prophets must be great indeed.

Of the many addresses delivered by Huxley, none is of greater weight and public importance than that on "Evolution and Ethics," the Romanes lecture in 1893, his last public appearance. Perfect in literary form and transparent clearness of argument, it is a remarkable display of the breadth and intensity of his outlook—a final summary of the convictions and philosophy of a man of piercing insight who, all his life, had been a student of social problems. In the lecture, he discussed the apparent paradox that ethical nature, while born of cosmic nature, is necessarily at enmity with its parent.

"Social progress means a checking of the cosmic process at every step and the substitution for it of another, which may be called the ethical process, the end of which is not the survival of those who may happen to be the fittest in respect of the whole of the conditions which obtain but of those who are ethically the best."

He was clear as to our duty: no words could be stronger than these:

"... To my knowledge, nobody professes to doubt that, so far forth as we possess a power of bettering things, it is our paramount duty to use it and to train all our intellect and energy to this supreme service of our kind.

"... The practice of that which is ethically best—what we call goodness or virtue—involves a course of conduct which, in all respects, is opposed to that which leads to success in the cosmic struggle for existence. In

place of ruthless self-assertion it demands self-restraint ; in place of thrusting aside or treading down all competitors, it requires that the individual shall not merely respect but shall help his fellows ; its influence is directed, not so much to the survival of the fittest as to the fitting of as many as possible to survive."

To use all but his own words, he was in no doubt that the cosmic process has no sort of relation to moral ends ; that the imitation of it by man is inconsistent with the first principles of ethics. Still, though it might seem an audacious proposal to pit the microcosm against the macrocosm and to set man to subdue Nature to his higher ends—the great intellectual difference between ancient times and our day lies in the solid foundations we have acquired for the hope that such an enterprise may meet with a certain measure of success. "I see no limit," he said, "to the extent to which intelligence and will, guided by sound principle and organised in common effort, may modify the conditions

of existence for a period longer than that now covered by history."

But to such end "We are grown men and must play the man

'strong in will  
To strive, to seek, to find, and not to yield,

It may be that the gulfs will wash us down,  
It may be we shall touch the Happy Isles,

... but something ere the end,  
Some work of noble note may yet be done.'"

Such was his last message. To-day, more than in his day, we need to give it heed, mindful of a far earlier exhortation :

Nought shall make us rue,  
If England to itself do rest but true.

The signs are ominous that we may have forgotten the conditions upon which success depends—perhaps in education especially. In no way has "science" been made to tell ethically, except in medicine.

### The Master.

By Prof. W. J. SOLLAS, F.R.S.

IT is now about sixty years since I received my first teaching in science in the College of Chemistry and the Royal School of Mines, and as my friend and fellow-student, Prof. Liversidge, lately exclaimed : "What a splendid education it was." Frankland, Tyndall, Ramsay, Smythe and Percy, a brilliant staff, guided us through an ideal curriculum, and thus prepared we proceeded, in 1868 I think, to Huxley, who in teaching us zoology, taught us a vast deal more besides.

I recall our first gathering in the lecture room of the Museum of Practical Geology. A few earnest students were seated round the green baize table immediately below the lecturer's desk ; the surrounding seats were almost, if not quite, empty. Punctually at the stroke of the clock Huxley entered the room and commenced his introductory lecture, which was devoted to a philosophical analysis and classification of the subject-matter of the "Science of Living Things," or, as he termed it, biology. I recall a slight feeling of disappointment, for I had expected to be plunged at once *in medias res*, but the lecture set me thinking ; it clarified and systematised my ideas, and had a general, as well as a special, application. I have shown my appreciation of it since in the sincerest way by borrowing it wholesale and using it in an adapted form as an introduction to the study of geology.

As the course proceeded and knowledge increased, I began to perceive certain incidental qualities which had hitherto escaped my attention. One was a precision in the use of scientific terms and a nicety in the choice of words in general—always the right word in

the right place. At first this was a source not only of enjoyment but of terror, for after the lectures loomed the inevitable examination, and it was obvious that as the master treated us, so in that day of dreadful judgment would he expect us to treat him.

From words we pass to sentences, and these were always concise and simple, yet so clear as to leave no room for doubt or ambiguity. Man is before all an imitative animal, and so these lectures in zoology became also a lesson in the English language.

As the language so the subject, first the facts given in precise detail and natural sequence : then embodied in a logical scheme.

The diagrams in chalk, drawn from memory on the blackboard, often as a running accompaniment to a description, shared in the same admirable qualities as the spoken words. They were masterly performances, the cod's skull in particular was a triumph. Those who have watched this sketch growing, as bone was added to bone, until this complex structure stood revealed as a whole and in all its parts, will not soon forget the pleasure with which they watched this notable performance.

Facts, based on personal knowledge and organised into a natural system, were the basis of all Huxley's teaching ; there was nothing *a priori*, and his powerful imagination, trained to its proper sphere, proved a faithful servant, never betraying him, as happens too often with lesser minds, by a treacherous domination.

This was eminently true of his treatment of evolution. The fact of evolution I think we took for granted, at

any rate we were abundantly supplied with the evidence on which it rests. The theory of evolution is another matter, but contrary to what seems to have been the experience of some of his critics, it was not shirked but fully expounded and illustrated. The exposition concluded with the statement that, *given* variation, heredity, and selection, then the Darwinian explanation affords a good working hypothesis.<sup>1</sup> But no attempt was made to account for what after all is the most fundamental of these factors, *i.e.* variation. This still remains the crux.

There was no zoological laboratory in those days, and consequently we saw less of our master than we desired, but a much-valued opportunity was afforded for conversation at the close of each lecture. On one of these occasions Huxley referred me for information to a German treatise, and on confessing that I could not read German, he spoke very impressively on the necessity of learning that language. At this I was very sorrowful, for after having suffered the drudgery of the classical method in an endeavour to learn the three languages which are usually inflicted upon boys at school, I had no desire for more. Huxley reassured me: "It is not so hard as it seems," he said. "Don't bother much about the grammar to begin with, but go straight to the book you want to read, translate the first ten lines with the aid of a dictionary, and learn all the words. Do this day by day and it will not be long before you will find to your surprise that you can read fluently and only need to use the dictionary now and then." I followed this advice and cannot be thankful enough for it. It has enabled me to add three or four other languages to my stock, and even to take a renewed interest in those of my school days. This was in 1869, and Huxley's plan is now, I believe, being advocated by influential teachers under the name of the "direct method." In how many ways Huxley was a reformer!

<sup>1</sup> Huxley was astonishingly open-minded, and I have sometimes wondered what hypothesis he had in view when many years later he wrote that new ideas often begin as heresies to end as superstitions.

The perfection of style by which Huxley's professorial lectures were distinguished was, I think, greatly owing to his singleness of aim, which was to assist us, so far as it was within his power, to a thorough knowledge of our subject. Consequently it was serious and simple, severely simple, only now and then, not often, relieved by a brilliant flash of humour which had about it a certain inevitableness and served to emphasise a point by its sudden illumination.

Thus, under a wise guidance, we traversed the whole of the animal kingdom, including man, taken not only as a type, but in all his manifold variety as manifested by the different races of mankind.

Huxley's delivery was sufficiently deliberate as to enable us—aided by occasional interruptions while diagrams were being drawn—to take down his words in full: my notes fill three bulky quarto volumes, to which, even after this lapse of time, I often turn for reference. The course extended over eighty-two lectures. I attended it twice, but much was changed in the second delivery; some subjects were more fully treated than before, others less, and much new matter was added embodying the results of the most recent research, much of it Huxley's own.

When I left London for Cambridge, and it was no longer possible to gather wisdom from the master's lips, instruction was still to be had from his published works, which followed in quick succession from his pen, and sometimes on memorable occasions even to listen, with a pleasure heightened by its rarity, to his well-remembered voice.

It was never my privilege to know Huxley as a friend; he was my teacher, that was all; with reverence and affection I worshipped from afar. Now as I look back over a long life I feel, while recognising how great is my debt to my many distinguished teachers, that I owe to him more, both morally and intellectually, than to any other I can name.

## Truth and Righteousness.

By STEPHEN PAGET.

IT is, or lately was, the fashion, among the young writers of essays and journalistic paragraphs, to poke fun at the Victorian Age. This fashion came into vogue before the War, and, happily, it is going out, or will soon go. Those of us living who remember the glory and the magnificence of the Victorian Age are able without dishonesty or hypocrisy to think gently of its failures and imperfections, and to enjoy heartily the unending pageant of memory. Only, in that pleasant diversion, we find ourselves watching, now one group, now another, of the chief actors in the

pageant. Above all, we find ourselves up against a question which is evaded by the young critics of the Age. What were the forces which went to the making of the Victorian Age?

A few years ago I set myself to try to understand the working of these concurrent forces. I wanted to discover the causes of the greatness of the Age, and the lines along which this greatness was ensured and established; and, as I read the written lives of the great Victorians, I perceived in them, as it were, a common endowment, the influences in later years of

a standard of purpose and ambition which had been set before them in the earlier years of home life. It was the way with home life, fifty to seventy years ago, to be favourable to discipline and self-discipline: and, among the young men who were thus started on the right road, the young men of science came to the front. It was a period in which the fine arts were hindered by general admiration of prettiness, and by general distrust of anything excessive, or indecent, or extravagant. But in the kingdom of the natural sciences, where nothing is pretty, nothing improper, nothing artistic, the young men were free: for they were in their own kingdom.

They accepted the discipline of home: they put strict limits to their ambitions, desiring not to be rich or conspicuous, but to have enough to live on quietly in the service of science. They set themselves to learn German: they kept themselves from the usual aberrations of thought among young men: and they took Carlyle as their guide and their prophet. Not one but many written lives testify to this upbringing and making of the men of science who were the glory of the Victorian Age. They had the kingdom all to themselves: there were no women of science in those far back days. But among these young men Huxley stands out: there is more in him than the early influences and circumstances of his life are sufficient to explain. If it were possible to isolate one representative character in whom the Age is manifest now, that would be Huxley. For, as the Age unfolded its purposes, there came the longing of the men of science to educate the people. Huxley is one of the foremost educators. A lot of this education—Working-men's College, and that sort of thing—has now a rather antique look: yet the passion for the sharing of knowledge profoundly inspired the men of science, and not them alone, but they took the lead: for, in the mind of the people, they had a message which none else could give. Especially, they had the message of evolution. But Huxley's work for education went far deeper than that: and we are bound to remember what he did for the London School Board. He worshipped the advance of education: and his influence abides in all the present ways of popular education.

Huxley stands out, among the men of his time, as one of the chief of our prophets. Like all prophets, he had his share of resolute fighting for the truth. To him, a man's principal duty was to hold and defend the truth, and to let nothing in life come between him and it. We had in Huxley a perfect example of zeal in preaching: there never was a more faithful servant of the truth.

The noise of the fighting is over. The time is not yet come for any sort of attempt to estimate the loss and the gain of it all. Perhaps, a long way ahead, there will be historians able to judge the issues of man's study of man: but, as things are now, we seem far from any kind of settlement of the fight which began over the name of Darwin. Only, we must remember Huxley not only as a fighting man. Never did anybody set himself more strictly to self-examination and to self-judgment. He was keen to educate everybody, but he was most keen to educate himself. He plunged himself deep into philosophy, he got as far as men ever get in Descartes and Hume and many

other authorities; his Romanes Lecture was merely the final output of years of hard thought: it was welcome to quiet minds, and it was the utterance of a quiet mind.

I wish that I could write of him as one of his pupils: I never came under the magic of his personal teaching. Merely, it was my good fortune as a son of Sir James Paget to see and hear many of the great Victorians, and, in the wonderful group of my father's friends, the vision of Huxley is very clear in my memory. Certainly, nobody but a fool could be unconscious that he was in the presence of a man immeasurably superior to the run of mankind. I remember especially the wonderful look of his face in the later years; the air of authority, the face showing signs of hardship and strain, the changing play of expression from gravity to laughter: above all, the brilliancy of his eyes, the paleness of his face, and the tossed-back mane of white hair. He was a lover of music: and I well remember, in my father's house, Lady Semon singing, and Huxley going down on his knee to kiss her hand in his gratitude for her song.

But what is the good of such memories, after all these years? We are going back now a hundred years to the time of his birth: we want something better than stray memories of him. That something better rests in the dominant idea of him as a great teacher and prophet, whose influence was extended over our country and over other countries. We have no such prophet now, not even in these days when our need of them is very urgent.

All his life, Huxley cared only to tell the truth, the whole truth, and nothing but the truth: he could not bring himself to any acceptance of half-truths, compromises, superstitions, and all sorts of guess-work. This was the secret of his love of fighting: so often as he came across a half-truth he had to hit it: and perhaps he hit it with especial fury if it were supported by some very powerful champion, for instance, Bishop Wilberforce, or Mr. Gladstone. But that is all over now: it was all involved in that adjustment of beliefs which made the Victorian Age not dull, as impatient young writers have been calling it, but supremely new and exciting. Anyhow, it was part and parcel of Huxley's preaching of the national need for truthfulness at all costs. Hereby he was a great prophet: and he was accepted far and wide as a prophet, accepted alike by learned men and unlearned. But no adjustments of the opinions and faiths of mankind, after all, are bound to last for ever. Even Huxley, in the later years, was still holding himself open to all opportunities for the re-adjustment and rebalancing of his mind.

It might be possible, if here was the place for it, to mark a contrast between him and Ruskin, the other great prophet of the Victorian Age: and there is nobody like them now. But they stand far apart in the range of their interests. Besides, they did not make the same appeal to mankind; moreover, there is the hard contrast between a man who had no family life, and a man who was devoted to family life.

The "Life and Letters" of Huxley, written by his son Leonard (Macmillan, 1900), give many pictures of the family life, and of Huxley's genius for friendship and for acts of generosity. Indeed, he cannot be isolated in our memories from his family and his friends. Yet our

first thought of him now is of a man who gave himself to endless work of teaching and of civilising. It seems a pity now that so little acknowledgment of his work came to him on any Honours lists; but the Order of Merit was not created in his time: still, there is a strange jump between him and a Privy Councillorship.

The beauty of his home life and of his character, and the magnificence of his work, his teaching, and his imaginative power over men can scarcely be put in print. He remains one of the leaders of thought in the past century: and we shall live to see new leaders of thought, but none with more power than was in him.

### Huxley's Message to the Modern World.

By Prof. T. D. A. COCKERELL, University of Colorado.

AMONG the memories of the past, few are more vivid than that of the unveiling of the Darwin statue in the great hall of the Natural History Museum. Addressing himself to the Prince of Wales and the Archbishop of Canterbury, representing the Trustees, Huxley uttered a message which in a manner summed up all his faith. He did not ask for their official sanction of Darwin's views; no man's verdict could make those views true or false, justify or condemn them. But Darwin's life, whatever the fate of his theories, must remain to us a glorious example, and future generations of students coming through yonder door might look on the image of his face and strive to follow his example.

Although Huxley always insisted that the universe was one, not two, and poked gentle fun at those who pretended to find a justification for dualistic thought in the existence of two cerebral hemispheres, this little speech of his revealed a kind of inconsistency which we all admire. He had no doubt that the operations of Nature followed a definite and consistent system, the workings of which were the subject-matter of scientific investigations. We were obliged to play our games, and must ascertain the rules to the best of our ability, for they would not be altered to please anyone. Eminent authorities might curse or bless, but the facts remained the same. Yet of all men living in those days, few had a keener sense of human worth than Huxley. I do not think I misunderstood him when he seemed to imply that, after all, the moral grandeur of Darwin's life must remain, no matter what might prove true concerning his opinions. Michael Foster, who knew him so well, did not hesitate to declare: "Great as he felt science to be, he was well aware that science could never lay its hand, could never touch even with the tip of its finger, that dream with which our little life is rounded; and that unknown dream was a power as dominant over him as was the might of known science; he carried about with him every day that which he did not know as his guide of life no less to be minded than that which he did know" (*NATURE*, Aug. 1, 1895, p. 320).

So Huxley lived in two worlds after all, but they were not separated in sharply defined compartments; they were as the warp and woof of the pattern of his intellect, inseparable and interdependent. What he said of Darwin we may well say of him, so that perhaps to-day his moral force is more valuable than his scientific contributions. The latter, at any rate, have been built into the structure of science, often as foundations now hidden by the building above. It becomes more and more difficult to discern exactly what his contributions were; they seem so much part of the body of knowledge that we can scarcely imagine the time when they were new. Thus the purely scientific Huxley tends to fade

from view, while the moral Huxley, intensely human and full of strong emotions, is no more likely to be forgotten than St. Francis. It is the latter aspect of his personality which now appeals to us, which strengthens our purposes and seems to point the way out of the perplexing confusion into which we have fallen.

When I try to imagine Huxley now among us, here in America, facing our present problems, I conceive that his counsel would be somewhat as follows: You cannot have successful democracy without moral sense, and that must show itself equally in tenderness of heart and honesty of purpose. It is not enough to mean well; you must do well, co-operating with the universe in which you live. The honest man faces the facts of existence and governs his conduct accordingly; he throws aside all sham and pretence, as soon as it is ascertained to be such. These are not mere pleasing generalities, but stern precepts in a land where ignorance is often enthroned, and masses of people pretend to believe that which in their hearts they know to be false. Power without wisdom, action without knowledge, must lead to catastrophe, no matter how excellent the political system, how worthy the traditions of the past.

Huxley himself would have put it better, but perhaps the meaning would have been about the same. Few there are, or have ever been, combining in one personality so many abilities: the keen intellect and the loving soul, the lively sense of humour and the power of wrath, the admirable expression and clarity of thought. But he of all men was the last to undervalue those of lesser breeds. He would bid us go forward with all courage confident of our ability to do something worth while. Probably he would stress, as he used to do, the importance of biology in education. There exists in the United States at the present time a strong movement supported by eminent educational authorities, practically to eliminate biology from High School education. In the larger cities the old High School course is being divided, the students of the first year being relegated to the newly established Junior High or Intermediate schools. Now it is widely proposed, with powerful supports, to offer biological subjects in the lower school, where they will be taught to very young students, but leave them out of the curriculum of the three years of High School proper. The result will be that pupils will graduate knowing little or nothing of biological theory, and having practically no real laboratory training. Administrators of schools will be saved a lot of expense in hiring well-trained teachers and purchasing apparatus. They will also avoid controversy over evolution and kindred matters. So insidious is this movement that few seem aware of it, but I think Huxley would be seen upon the heights, sounding the clarion of battle, were he here among us.

### Personal Impressions.

By C. V. BOYS, F.R.S.

AS I never took biology either as a student at the School of Mines or afterwards, it is only accident that ever brought me into contact with Huxley, and the occasions were few. They, however, have left a strong impression of appreciation of his kindness and of admiration.

On the first occasion I met him, so to speak, vicariously. As a student in the chemical laboratory I desired to see what the laboratory work upstairs was like, and I wandered up intending to see for myself. Huxley's demonstrator, Thomas Newton Parker, saw me, however, at once and explained very clearly that Huxley had no room in the laboratory for idle curiosity. On the next occasion, in 1879, at Guthrie's suggestion, I told him about some curious observations I had made on a number of different species of spider as affected by a tuning-fork. These interested him, and he recommended me to send an account of them to *NATURE*, where they were duly printed (December 16, 1880, vol. 23, p. 149). The Peckhams continued these observations in America.

Some years later I was offered a science mastership

at a public school and Guthrie again suggested that I should ask Prof. Huxley for his advice. I found Huxley and Col. Donnelly, who was then director of the Science and Art Department, together, and they most kindly went into the question with that knowledge of the world which I could not possess, with the result that I remained at South Kensington, and for this I am grateful.

Huxley's powers of exposition were amazing. That same curiosity, I hope not too idle, prompted me to attend one of his class lectures when I was a student. I think the subject was the internal economy of the cockroach, which as a subject did not interest me, but his clear exposition and his facility with chalk and the blackboard left a lasting impression. On a later occasion I attended his Friday evening discourse at the Royal Institution on "The Coming of Age of the Origin of Species." His almost painfully slow delivery—every word clear and carefully prepared—held the audience in rapt attention, and I remember well the expression in his peroration—more aggressive at that time than it would be to-day—"Man and other Animals."

### A Student's Reminiscences.

By Rev. E. F. RUSSELL.

IT was in the year 1875 that I, a curate of a London parish—S. Alban's, Holborn—was bold enough to introduce myself to Prof. Huxley. I had not been invited by him, or commended to him, nor had I any sort of claim upon the time and attention of so famous and so busy a man. I simply made a venture and knocked at the door of his private room on the top floor of the Science Schools, South Kensington. He was writing what seemed to be the minutes of a society meeting, of which he was secretary. Whatever he may have felt of annoyance at the intrusion and interruption of a stranger at so inconvenient a moment, he showed no trace of it in his manner, but simply asked my business. I told him that I had read and had been impressed by his remonstrance with the clergy who had denounced his teaching without having made themselves acquainted with even the first principles of the science upon which his teaching was based. Not that I myself had been guilty of that particular kind of folly, but I was conscious of an ignorance as complete as theirs, and was at a loss how to get at the knowledge that I lacked, not finding much that served my purpose in the text-books of the time. It was this sense of my ignorance that drove me to him for help. He treated me and my appeal with perfect courtesy, offered me a chair and a cigar, and proceeded to give me an outline of the course of instruction which he was just about to commence. The course lasted several weeks, and included a daily lecture, followed by some hours of practical work on the subject of the lecture in his laboratory.

This seemed exactly what I was looking for, and I closed at once with the suggestion that I should join the class. I remember having some misgivings as to how my fellow-students might regard the presence of

a clergyman in their lecture-room. If this now sounds absurd, it should be said that I was at that time visiting a clergyman friend who was a prisoner in Horsemonger Gaol for conscience' sake! My fears were quite groundless. I was not the only clergyman attending the lectures, for my neighbour in the laboratory was a Jesuit professor from the University of Louvain. It was known that we were both eager to learn and that was passport enough. As much could not, however, be said of all who attended the lectures, for some were there not because they loved the subject, but because they had to secure a certificate of attendance to qualify for some teaching appointment.

In spite of this, Prof. Huxley gave us of his very best. It was not a repetition of the last year's lecture, for he varied his course from year to year. Each lecture was a new lecture, freshly prepared for, not only by studies in the current biological literature, but also by laborious work in dissection and research. We students felt him to be the most enthusiastic student of us all. The order of our daily round was this. Each morning whilst the clock was striking ten—he was never late—the door from the professor's private room into the lecture-room opened and he passed swiftly to his platform. Without preface he took up at once his subject where he had left it the day before, and kept strictly to it without digression.

Half a century has passed since I listened to those lectures, and more than four score years of use have made some holes in the purse of my not very retentive memory; but my remembrance of the scene, of the voice and manner of the lecturer, of his keen and strong personality, is as fresh and vivid as if it were of yesterday. I recall it all as one might a voyage of discovery, full of wonder and delight. Since then

I have heard many admirable lecturers, but never another who was quite his equal in the affluence of his ready knowledge, in his power of apt illustration, in his ability to help us visualise what he described, in his command of pure English speech. At times, but not often, he lit up his subject by the summer-lightning of his humour. He was an expert draughtsman and turned his skill to account constantly on the black-board. It was interesting to watch him draw. He used coloured chalks, shading his drawing in parts with his finger and giving them a quality which made them not only instructive but easy to remember. I had expected that there would have been, on occasion, some reference to the current controversies with which Prof. Huxley was identified, but nothing of the kind happened, and the ultimate result of his words and influence, far from unsettling my beliefs, was to leave with me a new and delightful sense of the greater wonder, wisdom, power, and beauty of Creation by evolution than by an act sudden and complete.

After the lecture we passed on into the adjoining laboratory, where each one of us had his assigned table fitted with its microscope and other apparatus and instruments required. On our table each day a specimen of the subject dealt with in the lecture was placed, awaiting our study and dissection. The supply of specimens was ample and well chosen, like all else of the well-considered and generous equipment of the

laboratory. On the walls were many beautiful coloured diagrams, the work of Mr. G. B. Howes, who later succeeded Prof. Huxley as professor of biology. A small working museum was close by, which contained elaborate dissections preserved in spirit, and models of various organisms in successive stages of their development. Our demonstrator was no less a person than Mr. T. J. Parker, afterwards professor of biology at Otago, and a writer of authoritative books. Occasionally Prof. Huxley himself paid us a welcome visit and, glass in eye, examined and commented upon what we were doing. Even the laboratory "man" was an expert anatomist. He once set up for me the disarticulated skull of a cod-fish, and did the difficult task so well that the skull found a place in the Museum of St. Bartholomew's Hospital, Smithfield.

When, like Marcus Aurelius, in the evening of my life I look back upon past years and count up the names and benefactions of those to whom I owe so much, I find myself dwelling with especial gratitude upon the name of Thomas Henry Huxley, what he was and what he did; for from him I learned, so far as I was capable of learning, not only the principles of biology, and of the scientific method, but also, from his example, such high qualities as the habit of observation, accurate and intense, of patience and thoroughness in all we undertook, and—I would add—of courtesy to strangers.

### The Huxley Memorial Lecture and Medal of the Royal Anthropological Institute.

IT is especially incumbent upon anthropologists to preserve the memory of Huxley; for he did more than any other scientific thinker of the nineteenth century to remove misconceptions as to the aim of the science and to combat the prejudice with which it was regarded in the early days of its development. The Royal Anthropological Institute, however, is peculiarly indebted to him, for he was in a sense its founder. It was largely due to his tact and powers of conciliation when, as president of the Ethnological Society, he was carrying on negotiations with representatives of the Anthropological Society, that the differences of the two societies were composed, and an amalgamation followed which led to the foundation of the Institute in 1870.

At Huxley's death in 1895 it was the desire of the Council of the Anthropological Institute that Huxley's great services to anthropology should be specially recognised. A chair of anthropology had just been founded in the University of Oxford, to which E. B. Tylor had been appointed. It was felt that a Huxley professorship at one of the other universities would most appropriately perpetuate the memory of this side of his work. The suggestion was submitted to the Huxley Memorial Committee and received the support of Sir W. H. Flower; but it was not adopted. It was thereupon decided by the Council to supplement the objects selected by the Committee from among the many suggestions submitted to them, by the institution of a memorial lecture to be delivered

annually by a distinguished anthropologist, to whom a Huxley Memorial Medal should be awarded. By an agreement with the Memorial Committee, permission was granted for the use for this purpose of the die of the obverse of the Huxley Memorial Medal of the Royal College of Science which bears the portrait of Huxley.

The Huxley Memorial Medal of the Royal Anthropological Institute has come to be regarded as the highest award in Great Britain open to an anthropologist. The first award, appropriately enough, was to Lord Avebury, long Huxley's intimate friend, who delivered the first Huxley Memorial Lecture on November 13, 1900, taking as his subject, "Huxley, the Man and his Work" (see *NATURE*, vol. 63, pp. 92 and 116). The medal has since been awarded to a succession of distinguished anthropologists, both British and foreign, whose memorial lectures, while dealing with their subjects on broad lines in accordance with the terms of the foundation, have been, as a rule, at the same time of some considerable importance as contributions to anthropological science. Among those whose names appear in the list of medallists may be mentioned: Sir Francis Galton, Prof. D. J. Cunningham, Sir Edward Tylor, Dr. J. Beddoe, Sir Flinders Petrie, Sir W. Boyd Dawkins, Sir James Frazer, Sir Arthur Keith, Dr. W. Z. Ripley, Dr. J. Deniker, Dr. F. von Luschan, Dr. Gustav Retzius, Dr. E. Cartailhac, Prof. M. Boule, Dr. E. S. Hartland, Dr. A. C. Haddon, Prof. W. J. Sollas, and Mr. Henry Balfour.



SATURDAY, MAY 16, 1925.

## CONTENTS.

	PAGE
Science and Administration in East Africa. By Prof. J. W. Gregory, F.R.S. . . . .	753
The Herring. By B. Storrow . . . . .	755
Chemistry and Technology of Cotton-Cellulose. By Dr. J. C. Withers . . . . .	757
Seventeenth-Century Science. By Prof. Irvine Masson . . . . .	758
Our Bookshelf . . . . .	759
Letters to the Editor :	
The Essential Hormone of the Parathyroid Gland.—Prof. J. B. Collip . . . . .	761
The Preservation of Fishing-nets, Mosquito-nets, and Tent Fabrics.—Dr. W. R. G. Atkins, F.R.S. . . . .	761
Diagnosis of Ankylostomiasis.—Dr. M. Khalil; Lieut.-Col. Clayton Lane . . . . .	762
Homologies of the Genital Ducts of Insects.—Hem Singh Pruthi . . . . .	763
Fossils and Leonardo da Vinci.—Dr. Percy Edwin Spielmann . . . . .	763
The Identity of "Alumen" in Pliny's Natural History.—Kenneth C. Bailey . . . . .	764
Effect of an Alternating Magnetic Field on the Polarisation of the Resonance Radiation of Mercury Vapour.—Prof. E. Fermi and F. Rasetti . . . . .	764
Visible Wind.—Miss Catharine O. Stevens . . . . .	764
Single Spark Photography and its Application to some Problems in Ballistics. By P. P. Quayle . . . . .	765
Hindu Astronomy. By J. L. E. D. . . . .	770
Obituary :—	
Viscount Leverhulme of the Western Isles . . . . .	771
Current Topics and Events . . . . .	772
Our Astronomical Column . . . . .	776
Research Items . . . . .	777
Recent Researches in Positive Rays. By C. W. H. International Commission for the Investigation of the Upper Air. By Lieut.-Col. E. Gold, F.R.S. . . . .	781
Historic Scientific Instruments in the Old Ashmolean Museum, Oxford. By H. H. T. . . . .	783
Growth Stages of a Crustacean. By W. T. C. . . . .	783
University and Educational Intelligence . . . . .	784
Early Science at Oxford . . . . .	785
Societies and Academies . . . . .	786
Official Publications Received . . . . .	788
Diary of Societies . . . . .	788

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Science and Administration in East Africa.<sup>1</sup>

THE special geographical difficulties of tropical East Africa due to climate, remoteness, and the scantiness of the native population, have led to an awkward dilemma as to the labour and land policies. In consequence, serious friction arose between the European and Asiatic settlers and the Government, and widespread unrest among the natives. Accordingly, the late Government appointed a Commission consisting of the Hon. W. G. A. Ormsby-Gore (the present Under-Secretary for the Colonies), Major A. G. Church, then a Labour M.P. and secretary of the National Union of Scientific Workers, and Mr. F. C. Linfield, then a Liberal M.P., to collect information and report on the development of the British East African Dependencies, and on the social and economic conditions of the natives. The Commission, after a long tour of inspection, has prepared a valuable report on the countries and their administration. One of its most gratifying features is its recognition of the economic value to such countries of scientific guidance; and this welcome innovation enhances regret at the deplorable contrast described between the former attitudes of the British and German Colonial Governments towards scientific research.

Before the War, German East Africa was described in monumental scientific works which have taken their place amongst the standard contributions to the literature of tropical Africa; and several well-equipped scientific laboratories had been established. Mr. Ormsby-Gore and Major Church visited the Amani Institute, which was founded by the German Government in 1902. Its extensive grounds range from 1300 to 3600 ft. above sea level, with a branch establishment at sea level. The Commissioners report that the German Government spent 120,000*l.* on the station; they consider that it was superior to any corresponding institution in any British Colony, and compare it with Buitenzorg in Java. In its extensive grounds vast plantations of tropical shrubs and trees of economic importance were established; the laboratories investigated plant diseases and breeding, and analysed the soils; and the lectures of the expert staff and the publications explained its results to the colonists.

The War stopped all this useful work. The British Government in 1920 placed the Institute under the Agricultural Department of Tanganyika Territory. Sir David Prain, who reported on it in the same year,

<sup>1</sup> (a) Report of the East African Commission. (Cmd. 2387.) Pp. 195. (London: H.M. Stationery Office, 1925.) 3*s.* 6*d.* net.

(b) Education in East Africa: a Study of East, Central, and South Africa by the Second African Education Commission under the Auspices of the Phelps-Stokes Fund, in co-operation with the International Education Board. Report prepared by Dr. Thomas Jesse Jones. Pp. xxviii+416 +44 plates. (New York: Phelps-Stokes Fund. London: Edinburgh House Press, n.d.) 7*s.* 6*d.* net.

urged that the Director should be independent of any Department and responsible directly to the Governor, and urged its development as a central research institute for the British East African Dependencies. Their Governors were asked by the Colonial Secretary for financial support. Two of the five Dependencies were unable to contribute at the time, and the Institute remained under the Agricultural Department—with the results foreseen by Sir David Prain. Last year the Governor of Tanganyika recommended that the Institute should be closed; the Director resigned, and several thousand acres of adjacent land were announced for sale. The intervention of Mr. Thomas saved the Institute from this fate, and has given it another chance. The Commission strongly urges that a fresh attempt be made to maintain it by securing financial support from the five Dependencies, a substantial grant from the Imperial Government, and a suitable constitution. If these recommendations be carried out and Amani developed on the lines recommended by Sir David Prain, it should do for East Africa what Pusa is doing for India. It should be supplemented by local laboratories. Not only, however, was Kenya Colony unable to contribute to Amani, but its own institutes, the Naviasha Stock Farm, the experimental farm at Kabete, and the station at Mazeras were closed in 1922–23 on financial grounds—a “most unfortunate” step, say the Commissioners.

Amani should serve the main purposes of East Africa for forestry and economic botany. The Mpapwa Research Laboratory, also a German foundation, may similarly serve as the central institute for work on stock and their diseases, and the manufacture of serum; but so little is known in one East African colony of the progress in the next that the Commissioners were assured in Northern Rhodesia that the Mpapwa Institute was derelict, and they state that its results are unknown in Kenya Colony.

The Commission strongly recommends the extension of the geological surveys, and directs attention to the valuable results obtained by Dr. Dixey in Nyasaland and Mr. Wayland in Uganda. Tanganyika and Kenya Colony have neither of them at present a geological survey; in one case owing to action by the local government, and in the other by the Colonial Office. The Commission regrets the decision that the Nyasa Survey is to be suspended unless some profitable mineral be soon discovered. This policy seems particularly deplorable in regard to Nyasaland, which, in spite of its many advantages, remains the poorest of the East African colonies owing to the difficulty of communication with its port. As the Commission points out, a geological survey is not merely of value in discovering ores: its main service is in the prepara-

tion of a geological map which will help many departments of work as a guide to the distribution of the various types of soil, of underground water, and of such materials as clays, building stones, cements, limestones, and road metals, and in reference to public health. Local supplies of these heavy low-priced minerals are of high value in a remote country, and are indispensable to many industries. A new country has not the benefit of the experience of centuries of local observation to indicate where these materials can be found. They must be discovered by a scientifically conducted search. The maps of a geological survey in a newly settled country may repay their cost by avoiding waste in industrial and agricultural development. The Commission, it may be remarked, quotes Dr. Dixey, Government Geologist of Nyasaland, that water diviners, faith in whom is widespread in East Africa, and water-finding machines, are completely valueless.

The Commission strongly recommends the development of the Nairobi Museum, which was founded by the Uganda and East Africa Natural History Society. It has been suggested that this Museum should be extended as a memorial to the late Sir Robert Coryndon, and it is to be hoped that this scheme will be adopted.

Mr. Ormsby-Gore and his colleagues recognise that more funds should be provided for scientific work, and they urge the extension of the power and activities of the Colonial Research Committee. It was intended to have at its disposal 20,000*l.* per annum for five years; but its grant was cut down by the Geddes Committee to 2000*l.*, which, as the Commission remarks, is quite inadequate. “There can be no doubt,” says the Commission, “that increased provision under this head is one of the chief methods whereby Great Britain can assist her tropical possessions and her own trade. But, above all, it is essential that greater encouragement and better pay should be given to scientific officers in order that a supply of trained men shall be forthcoming from the Universities.”

The East African Commission has directed attention to the urgent need for Government co-operation in education. On this subject its proposals are endorsed by the recommendation of the Phelps-Stokes Commission, the chairman of which, Dr. Jesse Jones, is an expert on Negro education in America. This Commission was accompanied by Dr. Shantz, of the United States Bureau of Agriculture, who has prepared an instructive report on his observations. The Phelps-Stokes and Ormsby-Gore Commissions coincide in their chief educational views. They both express high appreciation of the missionaries' educational work, but recommend that it should be subject to Government inspection. The Ormsby-Gore Commission states

that if the missionaries knew what was being taught by some of the native teachers at the "so-called mission schools" they would stand aghast.

Mr. Ormsby-Gore's report includes several educational proposals which will be received with warm approval. In reference to one much-debated problem the Commission approves of elementary teaching in the language of the locality, and that where a second language can be taught it should be English. It also shows its practical insight by the recommendation, "We attach great importance to making natural science, as far as possible, the basis of higher education in African native schools." A knowledge of the three R's is, of course, essential, but they should be used for teaching the elements of natural science as illustrated by the life, agriculture, sanitation, and physical geography of the country in which the pupils live.

Mr. Ormsby-Gore's position as Under-Secretary of State for the Colonies should secure the adoption of his Commission's proposals. They would lead to a great advance in scientific research in East Africa, and help to remedy the various ills he and his colleagues were sent to investigate.

J. W. GREGORY.

### The Herring.

- (1) *Meddelelser fra Kommissionen for Havundersogelser*. Serie: Fiskeri. Bind VII.: On the Summer- and Autumn-Spawning Herrings of the North Sea. By Dr. A. C. Johansen. Pp. 118. (Kobenhavn: C. A. Reitzel Boghandel, 1924.)
- (2) *Ministry of Agriculture and Fisheries. Fishery Investigations*. Series 2, vol. 7, No. 4, 1924. First Report on Young Herring in the Southern North Sea and English Channel. Part I.: Distribution and Growth of Larval and Post-larval Stages, by Dr. William Wallace; with Appendix: The Water Movements of the North Sea in relation to the Geographical Distribution of Post-larval Herring, by J. N. Carruthers. Pp. 84. (London: H.M. Stationery Office, 1924.) 13s. net.
- (3) *Ministry of Agriculture and Fisheries. Fishery Investigations*. Series 2, vol. 7, No. 3, 1924: The Herring in Relation to its Animate Environment. Part I.: The Food and Feeding Habits of the Herring with Special Reference to the East Coast of England. By A. C. Hardy. Pp. 53. (London: H.M. Stationery Office, 1924.) 8s. 6d. net.

THE herring is our most important food fish. Workers in different countries are approaching the problems connected with it from different points of view. The accumulation of data tends towards both simplification and complication. It is possible that

increased hydrographic knowledge may assist us to foretell, to some extent, the nature of the fishery and that applied science may score a success, but the understanding of the subject is in the realms of pure science. The three papers specified above all help, in varying extent, to increase our knowledge.

(1) Dr. Johansen's work is a contribution to our knowledge of the racial characters of herring, and deals with, chiefly, the summer and autumn spawners of the North Sea. The numbers of vertebræ, keeled scales between the pelvic fins and anus, and rays in the pelvic, dorsal, and anal fins are treated statistically. Use is made of the results obtained by other workers. We have a comprehensive work which enables us to take a broad view of the subject of herring races.

The summer herrings of the east coast of Scotland, the Dogger Bank, the Jutland Bank herrings, and part of the Shetland summer herrings are all referred to one race, the Bank herrings of the North Sea. The main spawning-grounds of the race are near the British coast, from the Shetlands to Norfolk, and in the vicinity of the Dogger Bank. Spawning occurs also on the Little Fisher Bank and the Jutland Bank, including the adjacent waters of the Skager-Rack. It is indicated, however, that the Jutland Bank herrings have not been investigated sufficiently and that there are differences between the Scottish and Dogger Bank herrings.

In the attempt in Chap. x. to connect the racial characters of the Bank herring with temperature and salinity at the spawning-places, and compare the spawning of this race with that of the North Sea Deep-water herring and the Autumn herring of the German Bight, a great deal is assumed. The differences between the Bank herring and those from the deep water and German Bight are small. Comparison is made with herrings caught in the Kattegat, the Channel, northern waters, and the spring spawners of Scottish waters.

Following the general survey of shoals from waters adjacent to those yielding the Bank herring, an examination of the herrings of the Skager-Rack and Kattegat is given. The catches made from these waters show considerable fluctuations which have conveyed the impression that the fishery from about the entrance of the Baltic was one due to migrations. Johansen's work supports this idea and shows that, whilst Kattegat and Norwegian herrings are caught, the most important herring in these waters is the same as is found in the North Sea. This naturally leads to a consideration of Pettersson's work on periodicity in the fishery and, to a less extent, on the effect of currents, temperature, and salinity on migrations. As is pointed out by Johansen, there are two extreme views held with regard to migrations. One is that the herring is always a wanderer and has no fixed spawning-ground, and the

other is that herrings when they become mature return to where they were hatched.

It is highly possible that some herrings do return to the place of their origin, and there is much evidence which can be taken as indicating that spawning shoals return to the same spawning-grounds year after year, but there are indications that herrings spawn independently of when and where they were hatched. New spawning-grounds are formed; fisheries have been known to disappear; a change in the number of spawning fish on the grounds may appear, as has been the case recently in the East Anglian fishery; changes in extent and direction of migrations have been indicated; and whilst it is possible, for convenience, to think of spring and autumn spawners, it is also possible to have spawning taking place, in eleven months in the year, in the North Sea or waters adjacent. Further, the young are carried by the prevailing currents; they grow at different rates; there is evidence which points to shoaling being governed by size in immature shoals and by development in spawning shoals, and we have the fact that variations in development are great—young fish with two winter rings may be taken spawning, whilst virgins have been taken with as many as six winter rings.

It is a combination of all these which makes it difficult to think that the differences shown by Johansen are correctly defined by being named racial. There is a difference between herrings from different waters. It is one which can be expressed generally in terms of size for age, and the rate of growth decreases as oceanic conditions give place to those of narrow waters. There is evidence that a migration from narrow waters to oceanic conditions is followed by a great increase in the rate of growth.

If we arrange the data given by Johansen according to oceanic and narrow-water conditions, we find a gradual decrease in the number of vertebræ and an increase in the number of keeled scales. We have therefore much the same change as has been found for rate of growth. It is possible that the "racial" differences are such as could be produced in a generation by environment. The work of Schmidt, a short account of which is given, pp. 89-90, can be taken as supporting this view.

It is of interest that the high number of vertebræ found in spring spawners of the Firth of Forth supports the conclusion, arrived at from a consideration of the rate of growth, that some of these fish migrate south for spawning.

Whilst it is impossible to agree with the conclusions of Johansen as to the different races of herring, it is equally impossible not to have a high appreciation of the work he has produced. It is a very welcome work

and one which must be considered seriously by every one connected with herring investigations.

(2) This paper deals with the larval and post-larval stages, collected by the Ministry of Agriculture's research vessel, and those of Plymouth and Belgium, in 1921-1923. The material has been analysed by Dr. Wallace and helpers, and Mr. Carruthers has furnished hydrographic data which add considerably to the value of the work. Detailed accounts of the various cruises, the catches made, as well as a consideration of the hydrographic conditions, yield information which increases our knowledge of the drift of the young and also of the rate of growth. The work is well illustrated with charts and diagrams.

The area investigated was of considerable extent, and stretched from the Northumberland to the Cornish coast. It is to be regretted that, as the Dogger Bank area was not surveyed for spawning-grounds, records for comparative purposes in future years are not available. The high numbers of recently hatched fish found in the Southern Bight and the eastern end of the Channel make it desirable that the investigations do not come to an end before it is established, whether or no, spawning to such an extent as indicated can be considered a general condition.

The drift of the young brings about, in the Southern Bight, and to some extent in the German Bight, a mixing of autumn-spawned young of the North Sea with the winter-spawned young from the Channel. From the data supplied by Carruthers it is evident that the drift of the larvæ varies; and Wallace directs attention to the difficulty of assigning fry caught in the Southern Bight to either the Dogger Bank or the Channel race of herring.

This work should be read in conjunction with that of Dr. Johansen. No other paper, to the present writer's knowledge, has shown so well to what an extent the young from different spawning-grounds can be mixed, and, from the supporters of herring races, it calls for an explanation as to how and when the races sort themselves again.

(3) Most of the data in Mr. Hardy's paper are for southern North Sea fish, though young stages from the eastern portion of the Channel have been examined. The results of previous workers are given.

The food of the young consisted chiefly of diatoms and peridinians. With increased size there is a change in the food; larger plankton forms are taken and the smaller of the common copepods become of importance. After metamorphosis the range of food is increased, and it varies from the largest plankton forms to the eggs of shrimps and crabs. It is difficult to imagine how the latter can be of much importance. Their presence and the other foods found in the stomach point to the

herring taking practically anything which is floating in its vicinity. This makes doubtful Hardy's suggestion that varying numbers of *Pseudocalanus* in the southern part of the North Sea may be the cause of fluctuations in later years.

The food consists of plankton, and there is evidence that in spring the larger forms are selected. The presence of recovered spents may have influenced the curve given by Hardy, on p. 17, representing the feeding of the herring, which shows an interesting agreement with Lea's curve representing the growth of Norwegian herring.

A portion of the paper is devoted to various opinions as to how the herring takes its food. From the stomach contents and observations at Cullercoats, Hardy is of the opinion that feeding is selective and carried out by a definite act of capture.

Such diagrams as Fig. 11, or models in three dimensions as Hardy suggests, have their value and call for some ingenuity in their making, but it is doubtful if they are necessary. The price of the Ministry's reports is so great that only those interested in the subject are likely to buy. The majority of workers on fishery problems should be able to picture the results without such aids.

It may be that *Limacina retroversa* is a regular constituent of the plankton off the Northumberland coast in late summer, but we must have other reasons than a statement of belief before this can be accepted.

B. STORROW.

### Chemistry and Technology of Cotton-Cellulose.

*Cotton-Cellulose: its Chemistry and Technology.* By A. J. Hall. Pp. 228. (London: Ernest Benn, Ltd., 1924.) 30s. net.

WITH the establishment of the Linen and Cotton Industries Research Associations in England, and such institutes as the Kaiser-Wilhelm Institut für Faserstoffchemie in Germany, the number of "cellulose chemists" has increased considerably during the past few years, and many questions which have for too long been in doubt are beginning to show some prospect of solution. Indeed, so rapid are the advances in knowledge, that to workers actually engaged in this field a text-book has but little interest. There are, however, many reasons why a book should be written on cotton for the non-specialist scientific worker; first, to remove an impression that cellulose is a dull, inactive material only interesting in its technical applications, and secondly, to explain why those who do decide to experiment with it should supply precise information as to

the origin of their material and the conditions of their tests when recording results.

Mr. Hall has written such a book, but unfortunately he has begun too soon. The novel sections of his book are those in which he summarises, with little attempt at criticism, the newest results published in Great Britain, but we venture to suggest that as most of the work reviewed is mainly exploratory, a much more interesting story will be told in a few years' time. It should then be possible to write of discovered broad principles, rather than merely to record copious details of miscellaneous experiments. Furthermore, the author has not quite succeeded in quickening the imagination; true, he does show that cellulose is abundantly reactive, but not in such a way as to attract new workers with its possibilities for research. Nor does he succeed, except to those who already know, in emphasising the variability of cotton, and the difficulty of obtaining "cellulose" from it, free from mineral and other impurities but unaltered in physical and chemical properties. The method of the Cellulose Division of the American Chemical Society (p. 40) is probably too precise in specifying "Wannamaker's Cleveland cotton" as the source of "standard cellulose," but some explanation of the intentions behind this exactitude, on one hand, and, on the other, of the danger of regarding any promiscuous sample of surgical cotton-wool as "cellulose," should have been given.

The first chapter deals with the development, morphology, and physical properties of the cotton hair. Unimportant details are recorded about the convolutions which so strikingly distinguish cotton, but the most absorbing question—by what mechanism are they formed—is not discussed. The next chapter treats of the non-cellulosic materials in raw cotton and their removal. The use of enzymes and acids in bleaching should have received more notice, and the work on solvent extraction described later on (pp. 109-126) and the properties of "steam distillates" of cotton (p. 139) might well have come in this chapter. The interesting fact that Egyptian cotton contains more phosphorus and nitrogen than American, even when grown in the same environment, may be compared with a recent discovery that the sap in the Egyptian plant is richer in mineral salts.

The author next proceeds to deal with the action of alkalis on cotton. Surely water should have come first. The moisture content of cotton and its variation with humidity and temperature are so important in all processes from spinning to dyeing and calico-printing, and also in testing and storing, that more might have been written than the notes on pp. 79 and 137-139.

The chapter on the action of alkalis is one of the best in the book. It seems to be true that a curve connecting

concentration of alkali solution with the quantity of alkali removed from it by cotton shows a few steps corresponding with definite compounds of cellulose and alkali, but the curves connecting dimensional changes in the cotton hair with alkali concentration are much more difficult to interpret. How far this is due to the presence of a tenacious "cuticle" remains to be seen, but it is possible that some of the published curves need confirmation. It would have interested the general reader to be told the five or six different objects of "mercerisation." The statement at the head of p. 81 that "no adequate explanation of the increased absorptive power of mercerised cotton has been put forward" already needs modifying. The recent work of Katz on the X-ray analysis of mercerised fibres is most suggestive.

Chap. iv., on the action of acids, is good, but Chap. v. is a medley dealing with viscose, and the effects of mechanical stresses, heat, salt solutions, organic solvents, light, ammoniacal copper hydroxide solutions, water, moulds, and bacteria. In a new edition this will require complete revision, particularly as many new facts are already available. Some figures on the amounts of various solvents and salt solutions which a given mass of cotton can soak up might have been recorded; they are frequently demanded, but are not readily accessible.

The action of oxidising agents on cotton is the subject of Chap. vi., which is a sufficient summary of much conflicting material. Scarcely anything better has been written on "Oxycellulose" than Witz's original communications of nearly 120 pages in the *Bulletin de la Société industrielle de Rouen*, 1882-1883, and it is a calamity that only abstracts of this paper have been available except at one or two libraries in the whole of England. A weakness of the chapter is that it does not sufficiently indicate how cotton may suffer oxidising attack in practice, and how this affects its mechanical and dyeing properties.

Chap. vii., "Cellulose and Dyes," deals overmuch with dyes, giving unnecessary graphic formulæ, and not enough with dyeing. Scarcely anything is said, for example, on the factors affecting the penetration of cotton, and more might have been made of the theories of dyeing. Chap. viii., on the constitution of cellulose, has received the oversight of Sir James Irvine himself, and is an adequate summary of the contributions of organic chemists. There should have been some mention, however, of the X-ray work done in Germany.

Artificial silks form the main subject of Chap. ix. An adequate book on this subject is long overdue in English; for the present purpose, the chapter is no doubt sufficient. The final chapter gives some select methods for the estimation of nitrogen, phosphorus,

waxes and their characteristics, the "copper number," etc., of cotton. It was unnecessary to illustrate a pill press for cotton plugs (p. 221) and the space might have been given to some cross sections of various types of cotton and artificial silks.

The book is written in good style (except "this data is"), but a protest must be made against the constant use of "strength" of solution for "concentration" and "breaking strain" for "breaking load." The printing and illustrations are excellent though the tables are generally set too large. On pp. 76-77, for example, the story is broken into five times by small tables, and frequently much space is utilised to tabulate no more than two data. This makes the book less pleasant to read.

Whilst suggesting, therefore, that the book is not what one hopes to see written about cotton in a few years' time, the reviewer is justified in saying that a better summary of the knowledge available at the middle of 1924 does not exist. Mr. Hall is to be congratulated on his praiseworthy, though premature, attempt to reduce a colossal literature to its essentials in a readable manner.

J. C. WITHERS.

### Seventeenth-Century Science.

*Early Science in Oxford.* By R. T. Gunther. Vol. 4: The Philosophical Society. Pp. viii + 259 + 4 plates. (Oxford: The Author, Magdalen College, 1925.) n.p.

THERE are still to be met scientists who display impatience at the *haec olim's* of their own antiquarians, and regard the science of the seventeenth century and that of the twentieth as two provinces totally distinct. But on many hands a more understanding survey of those distant realms is growing; and those who find pleasure in the methods of science as well as in its results are nowadays in the position of that Dr. Smith who (p. 22)

"has undertaken to procure a new Chart, made by a Gentleman who has lately travell'd from Muscovy to China; by this Chart it appears, that those two Countries are not so far distant from one another, as our Maps commonly make them."

Mr. Gunther fills the valued rôle of one of the chart-makers, whose labours are bringing to light the near apposition of the seventeenth and the twentieth centuries in the basic methods of science; and indeed, the two are alike in more than method.

Let us see what is to be extracted from his latest publication, which appeared opportunely for the proceedings at the Old Ashmolean Building, described in *NATURE* of May 2 (p. 651). Nearly the whole of the book consists of the Transactions of the Philosophical Society of Oxford (1683-1690), transcribed *literatim*.

These have been accessible hitherto only in the original Ashmolean manuscript and in a copy made about eighty-five years ago for the library of the Royal Society. The selections from these records which have been appearing recently in *NATURE* well illustrate their matter, and make quotation here unnecessary; but in this book Mr. Gunther has annotated them with explanations, citations, and cross-references, and the whole is most useful to the student. These notes, and the re-edited Index, must be the product of a very great deal of labour, coupled with an acquaintance with the relevant sources such as probably no one but Mr. Gunther can compass, and the reader will not fail to acknowledge the authority which these editorial notes too modestly attest.

Mr. Gunther has prefixed an introduction of sixteen pages, reviewing the establishment of the Society, and exhibiting its near concern with the early Royal Society. The Transactions of the Oxford assembly refer, of course, to a period twenty to thirty years after the founding of the Royal Society, towards which by this time it stood in the relation of an adopted daughter and handmaid. There is, indeed, room for doubt concerning the continuity of the Oxford Philosophical Society after 1651, near which date it was founded for the first time—whether under its later name or not—by the distinguished men who had had the still earlier “Invisible College” in London. In the ‘fifties it was really a non-corporate cluster of brilliant workers, who were thereafter drawn for their organised scientific intercourse to Gresham College in London, where they founded the Royal Society. By 1683, however, a fresh generation of virtuosos had arisen at Oxford, with the grave old mathematician Wallis and the buoyantly inquisitive Dr. Plot as their mainstays, so that it became worth while to found the society anew; and it is at this stage that the doings portrayed by Mr. Gunther begin.

At a casual inspection, the spirit informing these doings is reminiscent of nothing so much as that of a private museum collected by Huckleberry Finn: excepting when it is in the vein of a solemn crank in a club—“what Creature makes ye greatest noise in proportion to its bigness? Probably ‘tis ye *Teredo*.” Such a comparison is unfair to many truly weighty contributions; but there is a measure of real truth in the attribution of a boyish love of oddities. For it was a time when an altogether new set of fairy tales had been made possible to read, in the shape of natural lore; and these charming amateurs were eagerly reading them for the delight of marvels newly revealed. For us, their tales have become old-fashioned, if we look merely at the facts told in them; but we still, like Huck and the old Oxford scientists, are lucky enough to have

the boyish hope of new surprises; and it is to the seedling which men like them fostered, and which is fructifying so fast in the twentieth century, that we owe our gratification of that hope to-day. In two or three centuries hence, our own present delight in quanta, protons, or vitamins will doubtless be looked upon as pleasantly ingenuous and even amusing; but these things will have been no more and no less necessary to the science of posterity than are the *Quaere’s* and discoveries of the seventeenth century to ours, for their purpose was our own and we derive it from them. Let us therefore “praise famous men and our fathers who begat us.” IRVINE MASSON.

### Our Bookshelf.

*The Mammals of South Australia.* By Dr. Frederic Wood Jones. Part 2: Containing the Bandicoots and the Herbivorous Marsupials (the Syndactylous Didelphia). (Handbooks of the Flora and Fauna of South Australia, issued by the British Science Guild (South Australian Branch) and published by favour of the Honourable the Premier). Pp. ii + 133-270. (Adelaide: R. E. E. Rogers, 1924.) 4s.

WITH the appearance of the second part of his review of the mammals of South Australia, Prof. Wood Jones completes the account of the monotremes and marsupials. It is at once the most exhaustive and comprehensive guide to these two groups that has yet appeared, and is distinguished for its originality of treatment, for the vast amount of most interesting observations on the habits of these animals based on an intensive field experience, and for the large series of clearly reproduced illustrations from original drawings which serve to elucidate the text.

Prof. Jones is revolutionary in his conclusions on the problems which are connected with the marsupials as a whole. He rejects the division of the group on tooth characters in favour of one based on the characters of the pes, and classifies them into Didactyla and Syndactyla. The former have retained their primitive polyprotodont condition, while the latter have become further differentiated into those retaining the primitive dentition (polyprotodont) and those in which the dentition has become specialised (diprotodont). This classification is based on the grounds that the syndactylous condition is not the result of degeneration, but of a specialisation resulting in a highly organised anatomical mechanism for combing the hair. As such it is more likely to have arisen only once in evolution than to have become developed independently in two different phylogenetic races. There are, moreover, no didactylous diprotodonts. In this view of the phylogeny of the group the author follows Bensley, and is in opposition to the generally accepted arrangement. The argument is put forward with considerable force and, it must be said, with conviction. Prof. Jones’s contention, too, that the marsupials reached Australia from the north, *via* Malay, is equally cogent, and deserves at least the considered attention of those who favour the alternative and generally accepted view of their immigration from South America.

*Palgrave's Dictionary of Political Economy.* Edited by Henry Higgs. New edition. Vol. 1: A-E. Pp. xviii + 924. (London: Macmillan and Co., Ltd., 1925.) 36s. net.

THOUGH this is the first volume of Palgrave's standard work, it is the second of the new edition to appear, and students of economics will have reason to be grateful to the publishers for furnishing them with so excellent a reprint of an extremely useful book. The plan of vol. 1 is precisely the same as that of vol. 2, which was reviewed in *NATURE* of February 16, 1924, p. 233. Only a few changes of any moment have been made in the new edition. The editor has added in an appendix a good deal of new matter. In the present volume the new matter takes up ninety pages, and dealing as it does with such subjects as banking, censuses, the conversion of the national debt, recent budgets, canals, libraries on economics, and the development of economic teaching in recent years in Great Britain, it serves a very useful purpose in bringing up to date some of the more important topics in the body of the book.

This additional information is so good that one is inclined to ask for more. The article on bimetallism, for example, might perhaps with advantage have found a place in the appendix; it would have been helpful to have been provided with even a few notes on recent developments. So, too, with the article on commissions of inquiry, which in the body of the book are noted up to the year 1905. The list might well have been continued to include the commissions of inquiry during the last twenty years. The same applies to the article on communism, in which of late there have been some interesting developments. But where there is so much that is good, it is perhaps ungracious to be discontented with omissions. It ought to be noted that the biographies form a useful feature of the volume, and the index, which is the soul of a book of reference, is particularly full and elaborate.

*Tychonis Brahe Dani opera omnia.* Edidit I. L. E. Dreyer. Tomus VII. Pp. v + 422. n.p. Tomus XI. Pp. iv + 414. n.p. (Hauniae: Libraria Gylden-daliana, 1924.)

THE appearance of these two volumes will be welcomed by all who are interested in Dr. Dreyer's monumental edition of the works of Tycho Brahe. We note that in the seventh volume Dr. Dreyer's name no longer stands alone on the title-page, but there is associated with him as co-editor Joannes Ræder. The present co-editor's assistance was acknowledged in the prolegomena to the tenth volume, which appeared in 1923, and the assistance given in the preparation of that volume is continued in the eleventh.

Vol. 6 of the series contained those astronomical letters written by or to Tycho Brahe which were published by him in his lifetime. Vol. 7 contains in chronological order the rest of his astronomical correspondence down to 1597. The series will be continued in Vol. 8, in which we are also promised notes on Tycho's correspondents and on the persons mentioned in the letters. The non-astronomical letters are reserved for Vol. 14. Most of the letters included in the new volume had been previously published, but the present text is based on MS. originals or MS. copies preserved for the most part

at Vienna. Perhaps the most interesting part of the correspondence is that with Thaddæus Hagecius of Prague, physician to the Emperor Rudolf II. Much of the contents of the letters is only distantly related to astronomy. Among the most interesting topics are the presence or absence of parallax in the new star of 1572 and in comets.

Vol. 11 continues the records begun in Vol. 10, and comprises the observations made from 1586 to 1589. The volume also contains a catalogue made in 1589 of zodiacal stars. The observations are very varied, and it is to be hoped that a good index will be supplied in a later volume.

*Life and Word: an Essay in Psychology.* By Dr. R. E. Lloyd. Pp. xvi + 139. (London: Longmans, Green and Co., 1924.) 7s. 6d. net.

DR. LLOYD'S thesis is that thought, which is verbal, "takes certain *definite* directions which are the directions of human behaviour, but circumstance does *not* lie around us in a *definite* order. How, then, can we take our thought from circumstance? It is, therefore, not taken from things, but given mysteriously." The very statement of the thesis would seem to exclude the problem from the purview of science; and, indeed, the book is rather one of philosophical reflection than otherwise, though it contains many acute observations of scientific relevance. The author raises the very ancient problem of the universals in a somewhat novel modern form; but his attempt to classify "humanity" by identifying it with "verbal-thought" will scarcely convince contemporary psychologists. This "verbal-thought" is looked upon by Dr. Lloyd as a function distributed among individuals, in a way similar to that in which a quality or characteristic is distributed among the members of a species, in that, as a whole, it is partly identical and partly different in any given individual.

The view that thought is a *differentia* of human individuals is not a new one. What Dr. Lloyd would emphasise is that it varies from one individual to another. But this has long been implicitly realised; and the stress laid upon individual differences by modern psychology is explicit. The difficulty is one inherent in classification, in which concepts must be used which neglect differences and consider only similarities. The little book is puzzling, but suggestive and stimulating to thought.

*The Book of Receipts: containing a Veterinary Materia Medica, a Pharmaceutical Formulary, a Photographic Formulary;* together with numerous Chemical and other Tables likely to be of use to Pharmacists and Manufacturers. By E. W. Lucas and H. B. Stevens. 12th edition. Pp. 473. (London: J. and A. Churchill, 1924.) 10s. 6d. net.

THE scope of this book is sufficiently indicated by its extended title. It is intended mainly for the use of pharmacists, but the photographic formulary and the sets of recipes for microscopical reagents and stains, waxes, varnishes, and special inks, etc., may be useful in scientific laboratories. The authors should consider the desirability of issuing these sections with additions as a separate laboratory receipt book. The collection is at present rather too eclectic to appeal to the average scientific worker.

### Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications*]

#### The Essential Hormone of the Parathyroid Gland.

THE essential hormone of the parathyroid gland has been obtained in certain extracts of the fresh glands of the ox (*J. Biol. Chem.*, 1925, 63, 395). Potent extracts have been prepared by first submitting the glands to acid hydrolysis under carefully controlled conditions. The active principle has thus been fractionated along with co-existent substances from the hydrosylate and thus obtained in a relatively high degree of purity.

That a principle contained in these extracts represents the essential normal internal secretion of the parathyroid gland has been shown by the fact that thyro-parathyroidectomised dogs on a lean meat diet, treated with these extracts, have been kept free from tetany so long as adequate dosage at proper time intervals has been maintained. The withdrawal of this treatment has resulted in the onset of tetany in these animals. Also, it has been shown that thyro-parathyroidectomised dogs which have developed tetany could be restored to normal by the use of potent parathyroid extracts. There is at this time in our laboratory a thyro-parathyroidectomised dog which was operated upon some four months ago. This animal is in perfect health. It has been treated continuously with parathyroid extract. Withdrawal of the extract for one day, even after four months of such therapy, has resulted in the precipitation of violent tetany, which has been relieved by the reinstitution of the treatment.

Along with many others, it has been our conviction that parathyroid tetany is primarily due to a lowered calcium content of the blood serum. It was a matter of great interest, therefore, to show that the administration of potent parathyroid extracts results in a mobilisation of calcium salts in the blood-stream. It has been found that potent parathyroid extracts cause a mobilisation of calcium not only in thyro-parathyroidectomised dogs, but also in normal dogs. Just as there is a typical blood-sugar curve following the administration of insulin, so also there is a typical blood-serum calcium curve following the injection of active parathyroid extract into dogs. The degree of hypercalcaemia induced in a dog by the injection of a parathyroid extract was also found to be directly related to the size of the dose administered. The potency of parathyroid extracts can therefore be determined with a fair degree of accuracy by the use of several normal animals which are under dietary regulation.

Repeated injection into normal meat-fed dogs of an active extract at intervals of a few hours, has resulted in a condition of profound hypercalcaemia. This condition, if maintained, has ended in a fatal issue. In such cases a typical train of symptoms has been manifested. Many changes in the physical and chemical characteristics of the blood induced by parathyroid hormone overdosage have been observed. Probably the most important of these changes in relation to the fatal issue is a decrease in blood volume and the consequent thickening of the blood itself. Preliminary experiments directed towards the antidoting of the symptoms of parathyroid hormone overdosage seem to point to this as the main factor to avoid or, if present, to counteract. Repeated intra-

venous injections of hypertonic glucose or saline solutions have proved of definite value. When such treatment has been instituted early in the case of dogs receiving repeated injections of potent extract, the animals lived longer than the controls. No absolute antidote has as yet been found.

It is also of interest to note that typical guanidine tetany has been induced in normal dogs at a time when they were also manifesting a condition of profound hypercalcaemia as a result of repeated simultaneous administrations of guanidine hydrochloride and potent parathyroid extract.

Experiments have shown as well that there is some intimate relationship between the habits of life of an animal and the function of the parathyroid glands. The rabbit, for example, has been found to be peculiarly resistant to repeated injections of the hormone, whereas the dog has been shown to be highly sensitive to it.

J. B. COLLIP

Department of Biochemistry,  
University of Alberta,  
Edmonton, Canada, April 18.

#### The Preservation of Fishing-nets, Mosquito-nets, and Tent Fabrics.

It has been shown by H. F. Taylor and A. W. Wells (Bureau of Fisheries, Document No. 947, Washington, 1923) that copper oleate dissolved in petrol or benzol is an efficient preservative for nets immersed in salt water. To avoid the creeping out of the soap to the surface on drying, the ten per cent. oleate solution receives one per cent. of mineral oil or of creosote. In fresh water, less satisfactory results were obtained unless a considerable amount of tar was added as a binder.

I have carried out a few tests, using this method, and the results have all been favourable. Silk plankton tow-nets become weakened in about three months' use, varying with the amount of wear. Previous work showed that this is in part due to the action of sunlight, but the major part appears to be due to bacterial action. Silk netting treated with copper oleate was kept in sea-water for six months, the water being changed every other day, and though in time the soap vanished the netting remained sound. Controls were much weakened inside five weeks, and shortly after that could be torn like wet paper. Since silk nets are costly, about 11/ for a set of four, and the preservative costs less than a shilling per net, the advantage of using it is obvious.

When tried on stout "stramin" (hemp) netting good results were also obtained, but less striking, for this material is vastly more resistant than silk. In addition to copper oleate a mixed copper soap specially prepared by Mr. W. A. Davis, of Messrs. Lever Bros., was also tried. This, being less soluble than oleate, was used in five per cent. solution. It has proved as efficient, or rather more efficient, than the pure oleate, though used in half the concentration.

After six months in sea-water the lighter stramin netting was found to be rotten, but the piece treated with mixed soaps remained sound, and single threads could only be broken with difficulty. The stouter stramin stank after six months in sea-water; though it could not be torn its appearance and feel had altered and single threads could be broken. The portions treated with oleate and the mixed soaps remained perfectly sound; single threads could not be broken by hand. A sufficient amount of copper soap remained on these pieces to render them much darker in colour than the untreated; of the two the mixed soaps appeared to remain on better than the oleate.

Linen and cotton tentings treated with oleate or

Lever's product lost much of the preservative on the outer side when exposed on the flat roof of the laboratory during the very wet months January and February. Fishing-nets treated with these soaps should therefore be protected so far as possible from rain; nor does hanging up to dry appear to be necessary, for sunlight is injurious to all fibres, and the copper soaps protect very effectively against rotting. The use of these soaps, mixed with tar for the heavier gear to lessen the rain effect, seems desirable. It may be pointed out that the soaps dissolve only when the nets are in water, but bacterial action goes on so long as the net is damp, so the immersion tests are in this respect unduly severe on the preservative.

The treatment of tent fabrics with copper soaps would appear to be useful in climates where the rainfall is not excessive, but where heavy dews prevail, as in parts of Egypt. In such climates fungal hyphae grow among and inside the cotton fibres and holes appear everywhere. The inner walls of the eastern pattern tents are also attacked.

The decay of mosquito netting in hot damp climates is sometimes a serious matter. Doubtless a dip in a dilute solution of copper soap would prove effective in prolonging the life of this netting. It could also be used for tennis nets and netting round the courts.

W. R. G. ATKINS.

Marine Biological Laboratory,  
Plymouth.

#### Diagnosis of Ankylostomiasis.

LIEUT.-COL. CLAYTON LANE, in *NATURE* of March 28, p. 478, criticised the modified floatation method adopted in Egypt for the diagnosis of ankylostomiasis. The principal modification lies in using a conical Erlenmeyer flask to hold the faecal emulsion in concentrated salt solution. This enabled the use of a large amount of fluid (100 c.c.), while the surface film does not exceed 1 cm. in diameter. Apparently Lieut.-Col. Lane did not give this method a trial, but applied to it the results he previously found in using an inverted metal cone.

Any trustworthy method for the diagnosis of ankylostomiasis intended for extensive campaigns should (1) be delicate enough to detect infection with one couple of worms of which one is a normally ovipositing female, (2) be simple and practical, and (3) not be time-consuming. It is not essential that the method should ensure the concentration in the surface film of the highest percentage of ova present in 1 c.c. of the stool so long as enough ova are present to ensure diagnosis. The examination is discontinued once a single ovum is detected.

If we accept Lane's statement, although it was not proved, that this method detects 7 per cent. of the total number of ova, and if we accept Stoll's result that a single fertilised female lays 44 ova per c.c. of the stool, we find that the method fulfils the requirements mentioned above, especially as the ova are unmasked and easily detected in films prepared by this method. Lane's results regarding the concentration of the ova, and Stoll's counts as regards the number of ova laid by a single female, have not yet been confirmed by other investigators. In view of this uncertainty, the anthelmintic (carbon tetrachloride) is administered to all patients attending the Ankylostomiasis and Bilharziasis Hospitals in Egypt since January 1924, regardless of the results of the microscopical examination. Re-examination after the first treatment is restricted to those in whose faeces ova were detected on the first examination.

In addition to the floatation method, a faecal smear is examined from every case in order to detect bilharzia ova, and incidentally ankylostoma ova. It

has been found that on an average 30 per cent. of the positive cases for ankylostoma are detected by floatation and missed in the smear. During re-examination after the first treatment, 90 per cent. of the positive cases are missed in the smear and detected by floatation.

Lane mentions as a proof of the inaccuracy of the method that in an Egyptian village in the Delta (Saft el Enab) only 16.6 per cent. were found to be infected with ankylostoma, while 40,000 examinations by the smear or centrifugal method showed an infection percentage in different parts of Lower Egypt of 48 to 97 per cent. I am unaware of the source from which he got his figures as regards the 40,000 examinations. I may, however, mention that the degree of infection in the Delta varies considerably. Using the technique mentioned above, it was found that in villages in the neighbourhood of Cairo the infection may be so high as 88 per cent., in the neighbourhood of Benha 60 per cent., in the neighbourhood of Mansura 34 per cent., in the neighbourhood of Dessuk 16 per cent. The percentage of infection diminishes as we travel northwards. It is probable that atmospheric temperature influences the incidence of infection in these different localities. This subject is being studied at present. The Delta of Egypt is a large territory, and it is inaccurate to treat it as a whole as regards the incidence of ankylostomiasis.

As regards the importance of accurate study of ankylostomiasis from its various aspects in Egypt, I may assure Lieut.-Col. Lane that the Egyptian Government is fully alive to its responsibility. It had already started, towards the end of 1922, a research section devoted to the study of ankylostomiasis and bilharziasis. M. KHALIL.

Department of Biology and Parasitology,  
Royal School of Medicine, Cairo, Egypt, April 4

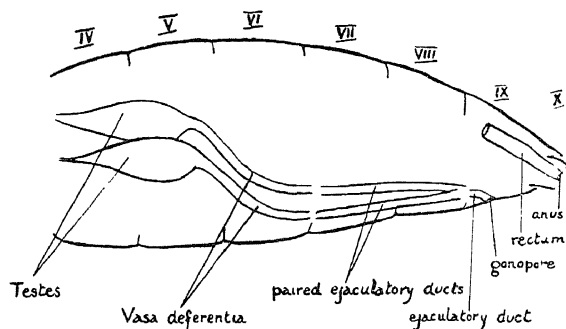
THE community percentages of hookworm infection for Egypt of 48 to 97 obtained by the use of Howard's, the least efficient concentrative diagnostic technique, emerge from analysis of Khalil's tables. A percentage of 16.6 for his floatation method indicates then either an unluckily chosen experimental site or an undependable technique. It was held that the evidence suggested that the latter factor was involved. This conclusion would indeed seem to be Khalil's also, since he writes: "It is probable that some of my negative results were due to the very few ova which escaped the attention of the examiner" (p. 82). Put otherwise, his first requisite for a trustworthy diagnosis—namely, that the technique must be "delicate enough to detect infection with one couple of worms of which one is a normally ovipositing female"—is an ideal which he so far as is known, unattained by his own technique.

But the fundamental point in the criticism lay in that, being without knowledge of the number of ova with which, in any instance, his technique started, he necessarily remained ignorant of the percentage which it finally delivered. The later statement, that it is better than the worst concentrative technique, does not even now rectify the matter. Its real value can only be indicated by such methods of control as are being applied in various parts of the world, already with a considerable measure of success. Without a controlled, and therefore scientific, basis for the work, the Egyptian campaign, so heavily subsidised by the Rockefeller Foundation—at the expense of which so much of the recent widespread experimental work on control has been carried out—must clearly remain of minor value.

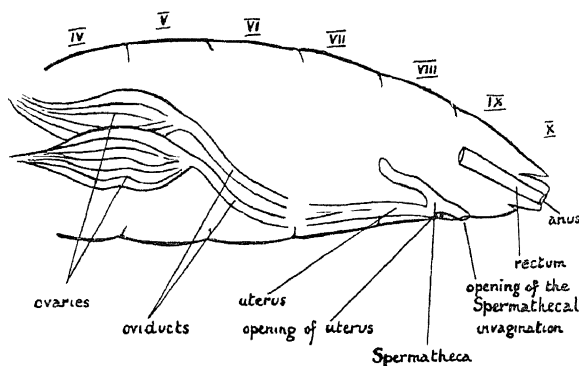
CLAYTON LANE.

### Homologies of the Genital Ducts of Insects.

It is unfortunate that even the most recent textbooks of entomology are not up-to-date in their accounts of the above organs. It is only with regard to the ectodermal parts of the ducts that opinions have differed; otherwise it is admitted by all that ovaries and oviducts correspond to the testes and vasa deferentia respectively. In every book, old or new, one finds the median ejaculatory duct homologised with the median vagina. This homology is open to serious objection: the ejaculatory duct opens in all insects, excepting the Ephemeroptera, behind the ninth sternite, and is unpaired from the very beginning, while the vagina or the uterus opens in



Male



Female

FIG. 1.—Scheme of the development of the reproductive organs of an insect. Accessory gland not shown.

most insects between the eighth and ninth sterna, and is paired in origin in many orders.

In the young male there is an hypodermal invagination of the body wall behind the ninth sternum, the rudiment of the median ejaculatory duct. This invagination at its anterior end, about the posterior region of the eighth sternum, meets and opens into a pair of ectodermal ducts, termed the paired ejaculatory ducts, which as development proceeds get into communication with the vasa deferentia. In the case of the young female there is also an invagination of the integument behind the ninth sternum, which develops into the spermatheca. The spermathecal rudiment about the posterior margin of the eighth sternum opens into an ectodermal duct, the uterus or vagina, which, as mentioned above, arises in many insects by coalescence of a pair of ducts. The uterus at a later stage in development becomes continuous with the oviducts. Evidently, therefore, the median ejaculatory duct of the male corresponds to the

spermatheca of the female, and not to the vagina or uterus. The homologue of the latter are the paired ejaculatory ducts. Diagrams of the scheme of the organs appended will illustrate the above remarks (Fig. 1).

The only difference (but which has caused a considerable amount of confusion) between the organs of the two sexes is that while the median ejaculatory duct meets and opens into the paired ejaculatory ducts at its extreme anterior end, the spermatheca does so about the middle of its length, with the consequence that its anterior half remains free, increases in size, and appears as a diverticulum of the uterus. Moreover, unlike the uterus, the paired ejaculatory ducts have no opening of their own in the preadult insects. But in Coleoptera, and probably in Diptera also, the uterus, like the latter, has, morphologically speaking, no opening of its own and communicates with the exterior through the opening of the spermatheca, and therefore the female gonopore, unlike that in other orders, lies behind the ninth sternum. The spermatheca, except in the Coleoptera, Diptera, etc., loses its proper opening and communicates with the exterior by the opening of the uterus. In the Lepidoptera, however, both the spermatheca and the uterus retain their proper apertures even in the adult stage, with the consequence that there are two "genital openings," one behind the other, in this order. In the Ephemeroptera also there are two openings, but they lie on the same segment, the seventh.

HEM SINGH PRUTHI.

Zoological Laboratory,  
Cambridge, April 22.

### Fossils and Leonardo da Vinci.

IN his valuable and sympathetic appreciation of Huxley on the occasion of the centenary celebrations on May 4, Prof. Poulton incidentally referred to the puzzled discussions of naturalists of former days concerning the fossil sharks' teeth ("glossopetræ") that were found in Italy.

It is interesting to compare their mental attitude and their almost complete and unimaginative ignorance with the acute and unerring perception of the supreme genius of all time—Leonardo da Vinci.

In "The Literary Works of Leonardo da Vinci" (Richter, 1883, p. 208 *et seq.*) he discusses very fully the presence of fossils in the Italian mountains. His immediate object is to show that the Noachian flood could not be responsible for this; and his many-sided arguments indicates the clearest understanding of the formation of strata by deposition from rivers, and of earth movements, in their connexion with the preservation and present position of fossils. His particular views are supported by the following statement:

"And if you were to say that these shells were created, and were being continually created in such places by the nature of the spot, and of the heavens which might have some influence there, such an opinion cannot exist in a man of good reason; because here are the years of their growth, numbered on their shells, and there are large and small ones to be seen which could not have grown without food, and could not have fed without motion—and here they could not move." With such a mental attitude (existing at a period that was steeped in astrology) what a mighty ally Leonardo would have been to Darwin and Huxley!

One of his other arguments against the assistance of the Deluge, in the part of Italy that he investigated, is characteristic of his incessant interest and scientific watchfulness: "We have it in the Bible that this

deluge lasted 40 days and 40 nights of incessant and universal rain . . . and if you were to say that . . . the shells quitted their first home" [near the seashore] "and followed the increase of the waters up to their highest levels . . . I answer, that the cockle is an animal of not more rapid movement than the snail is out of water, or even somewhat slower; because it does not swim, on the contrary it makes a furrow in the sand by means of its sides, and in the furrow it will travel each day from 3 to 4 braccia; therefore this creature, with so slow a motion, could not have travelled from the Adriatic Sea, as far as Monteferrato in Lombardy, which is 250 miles distance, in 40 days, which he has said who took account of the time. . . ." The last few words are probably not free from an intended gentle sarcasm (we meet it again elsewhere); but how unanswerable is this argument, as are many others, of this brilliant observer and thinker!

Leonardo refers also to "the bones and teeth of fish, which some call arrows and others serpents' tongues . . ."—surely the very "glossopetræ" already mentioned.

What puzzled naturalists of later times was abundantly clear to him of the fifteenth century.

PERCY EDWIN SPIELMANN.

The Athenæum, May 5.

### The Identity of "Alumen" in Pliny's Natural History.

"ALUMEN" is mentioned frequently in the *Historia Naturalis* of the elder Pliny, and there has been some controversy about its identity. It is probable that the term was used loosely to describe a number of astringent salts, and it is clear from the tests prescribed in Pliny, H.N. 35, 184-5 (the blackening of pomegranate juice and nut-galls), that the word was sometimes used to describe a compound of iron, perhaps the sulphate, derived from iron pyrites by oxidation. Ajasson, however, boldly identifies the "alumen" mentioned in H.N. 33, 88, as sulphate of aluminium, but gives no reasons for so doing.

The passage in question concerns the preparation, for use as a pigment, of "chrysocolle." Though the identity of this latter substance has been a matter of dispute in the past, there is now general agreement that it was malachite, or basic carbonate of copper. The passage runs as follows:

H.N. 33, 87. "Chrysocolle" illa quoque herba quam lutum appellatur tinguatur. . .

88. "Pulvis (sc. chrysocolle) semper in catino digeritur et ex aceto maceratur ut omnis duritia solvatur, ac rursus tunditur, dein lavatur concisis, siccatur. Tunc tinguatur alumine schisto et herba supra dicta, pinguiturque antequam pingat. . .

89 "Summa commendationis, ut colorem in herba segetis laete virentis quam simillime reddat."

There is little doubt that "lutum" is the "reseda luteola" or weld, an extract of which dyes yellow with aluminium mordants and greenish olive with iron mordants.

The writer prepared an extract of weld by boiling the chopped-up plant with water. Finely-powdered malachite (bluish-green in colour) was treated with vinegar, washed, and boiled with weld extract to which had been added (a) aluminium sulphate, (b) ferrous sulphate, or (c) iron alum. The colour finally obtained depended on the proportions of dye and mordant and on the time of boiling, but in a general way (a) gave an emerald green powder, while (b) and (c) gave dark greens—approximately the colour of the holly leaf.

It seems clear that the former is the colour referred to as "colorem in herba segetis laete virentis" rather than the latter. It is almost certain, therefore, that

"alumen" includes salts of aluminium as well as salts of iron.

In conclusion, it should be added that Dioscorides (5, 104), in a sentence the exact meaning of which is uncertain, seems to describe "chrysocolle" as being of "a full leek green," but it is probable that he is speaking of the original material and not of the dyed product as he does not mention the dyeing process at all.

KENNETH C. BAILEY.

Trinity College, Dublin, March 23

### Effect of an Alternating Magnetic Field on the Polarisation of the Resonance Radiation of Mercury Vapour.

RECENTLY, A. ELLETT (*NATURE*, December 27, 1924, p. 931) and W. HANLE (*Zs. f. Phys.*, 30, 93, 1924) observed the depolarising effect of a weak magnetic field on resonance radiation. When the intensity of the field was sufficiently small they found, not only partial depolarisation, but also a rotation of the plane of polarisation. This is accounted for, on the classical point of view, by the superposed effect of the Larmor rotation and of the damped vibrations of the oscillator.

The same classical views suggest that the depolarising action of a high frequency alternating magnetic field of constant amplitude will vary with increasing frequency. The effect should be well observable with fields of 2 or 3 gauss, and frequencies between  $10^6$  and  $10^7$ .

We have performed the experiment, and have detected the presence of the expected phenomenon. A strong increase of the polarisation was actually observed in passing from a frequency of  $1.5 \times 10^6$  to one of  $5 \times 10^6$ , though the amplitude of the field remained constant.

We are carrying out further experiments in order to determine the quantitative features of the effect.

E. FERMI.

F. RASETTI.

Istituto Fisico dell' Università,  
Firenze, Italy, April 3

### Visible Wind.

IN reference to the report published in *NATURE* of May 2, of the Royal Meteorological Society's "Celebrations," including the interesting address by Prof. E. van Everdingen on "Clouds and Forecasting Weather," may I be allowed to remind international meteorologists that in 1906, by official sanction in Great Britain, the status of "wind waves" was raised from that of a purely theoretical deduction to that of a normally observable natural phenomenon. "Wind waves" operating in the free and cloudless air are recognisable as such from among other sources of deformation of the definition of telescopic images. They are most adequately observable by means of a telescopic image of the sun projected for the purpose into a darkened room. Their approximately horizontal progressive wave-motions describe prevailing conditions of atmospheric stratification, wind directions, and turbulence above the place of observation always ahead of and generally many hours ahead of any visible formation of associated clouds. Thus the main objects of cloud-observation are obtainable by means of yet earlier observations of winds, up to all heights of known cloud formation, in any brief moment of sunshine, with the utmost ease and expedition. But Ruskin is aptly quoted by the writer of the report to the effect that "the meteorologist is impotent if alone."

CATHARINE O. STEVENS.

The Plain, Boar's Hill, Oxford.

## Single Spark Photography and its Application to some Problems in Ballistics.

By P. P. QUAYLE, Assistant Physicist, U.S. Bureau of Standards.

SPARK photography, in which the illumination is provided by an electric spark of such short duration that a moving object appears stationary, has many applications in the investigation of high-speed phenomena. The record obtained is not an image, no lens being used, but is simply the silhouette of objects between the light source and the photographic plate. Two distinct problems are presented in the photography of moving objects. One of these is the timing of the spark so that the desired epoch of the phenomenon under investigation may be photographed, and the other has to do with the duration of the spark. All the photographs described in this article were taken on plates not larger than 8 by 10 inches. A projectile moving at a speed of 2700 feet per second would be in front of such a plate, and therefore in a position to be photographed, for only 0.0003 second. If the projectile is to be photographed within an inch of a predetermined position, the time of occurrence of the spark must be correlated with the position of the projectile to within 0.00006 second.

The spark duration determines the amount of blurring, for if the projectile moves while the plate is being illuminated a streak will be recorded, the length of which depends on the duration of this spark. If the blurring is not to extend over more than one-sixteenth of an inch for a projectile moving at a speed of 2700 feet per second, the time of exposure must not exceed two millionths of a second.

It is interesting to contrast the requirements which are imposed upon the apparatus just referred to with those imposed upon ordinary moving picture cameras in taking the so-called action photographs of the daily press. While many camera shutters are rated to operate in 0.0006 second, they seldom function in less than 0.002 second, and 0.005 second is a more common time of exposure. In photographing a racing car moving at 120 miles per hour, using a shutter which operates in 0.002 second, the car will move approximately 4.2 inches during the exposure interval. Exposure times which are satisfactory for photographs of polo matches, track and field work, etc., are ten times too long for photographing a racing car and ten thousand times too long for photographing a projectile at right angles to its trajectory. If the photograph is not taken at right angles to the trajectory the requirements are less severe. This point is well illustrated in the case of a 4.7 in. field-piece, say, firing so that the projectiles are silhouetted against the sky. If the day is clear, an observer standing behind the piece can see the projectile with the naked eye at a distance of three hundred yards from the muzzle and follow it without difficulty for a thousand yards or more along its trajectory.

In order to secure a properly timed spark of suitable character there must be available a means of generating electrical energy at very high voltage; a means of storing such energy; apparatus for the regulation of the voltage; and finally, a means of releasing the stored energy at the proper time. The manner in which these parts are associated is shown diagrammatically in Fig. 1. In our equipment the generator consists of a motor-driven influence machine having two revolving plates 17 in. in diameter. A 0.024 microfarad Leyden jar condenser constitutes the means of storing the energy for the photographing spark. The apparatus for regulating the voltage of the condenser includes a dynamometer or potential regulator and a switch which disconnects the condenser from the influence

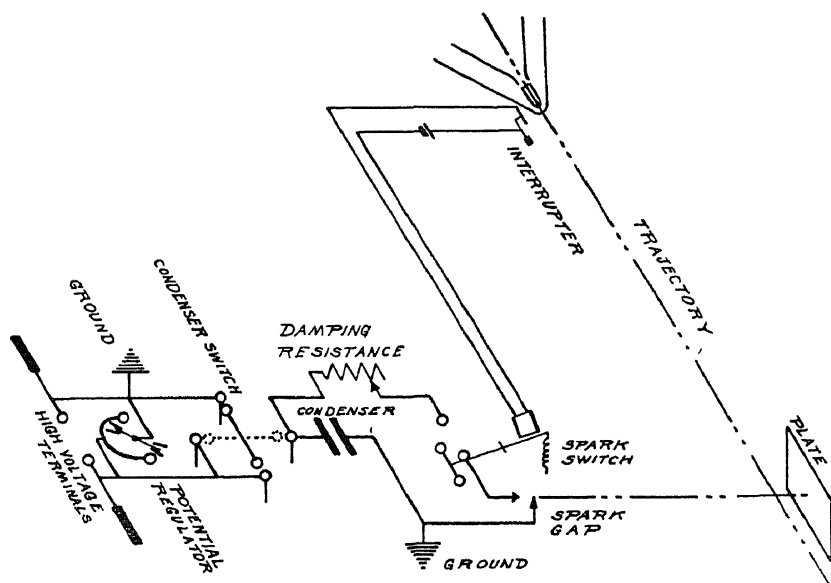


FIG. 1.—Schematic wiring diagram of spark photography apparatus.

machine when the voltage across its terminals reaches a definite value determined by the regulator adjustment.

The arrangement for releasing the photographing spark also consists of two parts. The first part is an electromagnetic switch which closes a trigger spark gap. The second is an auxiliary device which serves to time the operation of the previously mentioned switch with respect to the phenomenon to be photographed. This auxiliary device takes different forms in varying circumstances. For example, when projectiles are being photographed well away from the gun, an interrupter is used which is placed near the trajectory and opens an electric circuit when the head wave of the bullet passes over it.

## CYCLE OF OPERATIONS.

When a photograph of a projectile is to be taken, the following steps are involved. The operator sets or cocks the spark switch and the condenser switch, having previously placed the interrupter a short distance away from the trajectory and at a sufficient

distance from the photographic plate to allow for the 0.0048 second time lag in the apparatus. This position

interrupter in its progress toward the plate. As the sound waves which accompany the bullet pass the interrupter the circuit breaker is thrown open, the magnet of the relay is de-energised and the armature catch is released. The switch arm then closes the trigger gap and the condenser discharges through it and the photographing spark gap with which it is in series. If the interrupter has been properly located, the spark occurs at the instant the bullet arrives in the desired position in front of the plate.<sup>1</sup>

#### COMPARISON WITH OTHER METHODS.

The first spark photographs of projectiles in flight seem to have been taken about 1881 by Prof. E. Mach, of the University of Prague, who carried out a remarkable series of experiments along this line. Prof. Mach utilised the so-called Schlierenapparat devised by Toepler for making visible those portions of a transparent medium which differ but slightly in refractive index from that of their surroundings. Hence his images were small and required the utmost in photographic manipulation to develop them. Prof. Mach triggered his photographing spark by firing the bullet through a secondary trigger gap, and while this method is positive, the wires of the trigger gap appear in the photograph.

Dr. L. Mach, in 1893, attacked the problem with several modifications of the earlier apparatus and a most ingenious trigger device. His efforts were attended by marked success. L. Mach's

is determined by trial. The lag of the spark switch may be determined experimentally. If this lag is known, a simple computation based on the approximate speed of the projectile and the lag value will definitely determine the position for the head wave interrupter. After the influence machine has been started, the voltage across the condenser builds up until the point is reached at which the regulator functions. The closing of the regulator contacts energises the tripping magnet of the condenser switch, which in turn promptly disengages the arm and short-circuits the influence machine, thus preventing the accumulation of further charge on the condenser. This arm, through the buffer, automatically turns on the signal light and the operator immediately fires.

The bullet moves out from the muzzle and passes the

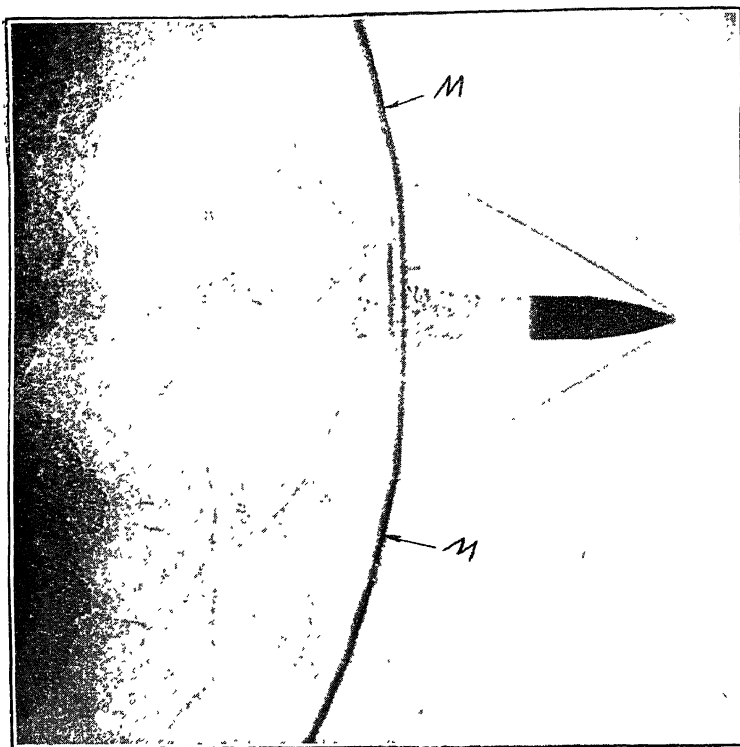


FIG. 2.—Bullet from a Springfield rifle about 12 in. from the muzzle. The bullet is well in front of the muzzle. M is the boundary wave.

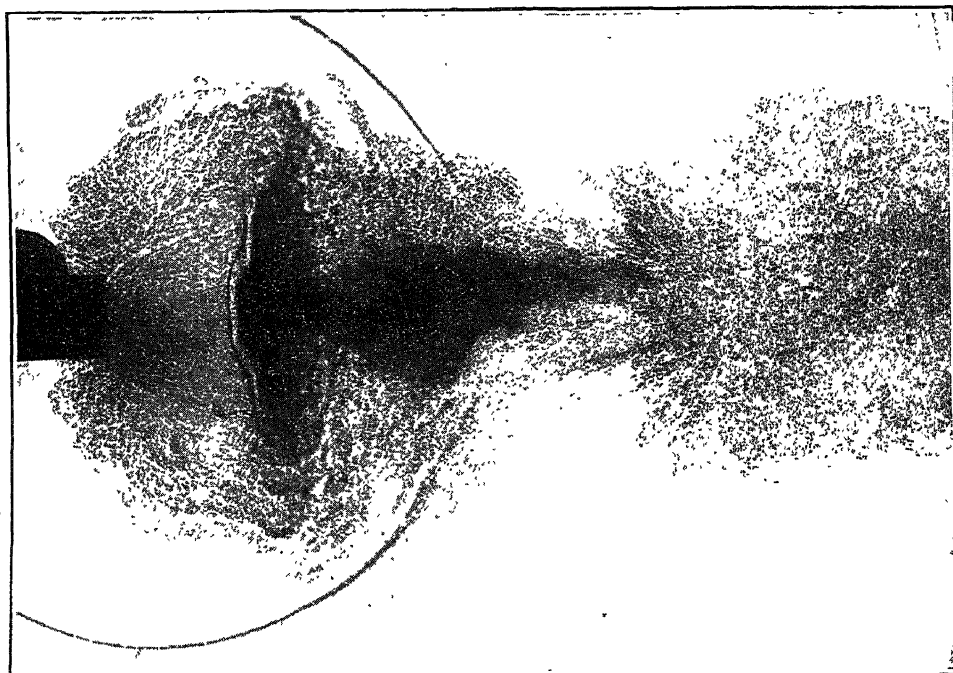


FIG. 3.—Bullet from a 0.45 revolver about 14 in. in front of muzzle.

<sup>1</sup> A more detailed description of the apparatus with illustrations is given in a Bureau of Standards paper now in press entitled, "Single Spark Photography and its Application to Ballistics."

apparatus was also based upon Toepler's method, but he replaced the lens of the earlier apparatus by a large concave mirror, which gave a larger field and more intense illumination. L. Mach triggered his spark by means of a compressional wave started by the passage of the projectile through a special device designed for the purpose.

From data found in Mach's papers, and from general information concerning the rifles in use at the time his work was done, it appears probable that the speed of the projectiles photographed by him did not exceed 1900 feet per second.

C. V. Boys<sup>1</sup> in 1893 introduced the direct shadow method of bullet photography employed in this paper. The sound waves and other air disturbances produced by the flight of the bullet are recorded in the photographic plate owing to the fact that their refractive indices differ from that of the surrounding air. Boys used the triggering device employed by E. Mach, which shows in each picture, but his photographs are among the best ever obtained.

Excellent photographs similar to those of Boys were published by W. A. Hyde in Ordnance Pamphlet, No. 422, U.S. Navy Department, in 1913.

All the methods of photographing projectiles in flight discussed up to this time have one point in common, namely, that in triggering the photographing spark the motion of the projectile is interfered with in some way. In the earlier triggers, the projectile closed a gap mechanically. Then L. Mach fired his bullets through paper cylinder heads causing a compressional wave in a small tube. The use of the interrupter described here, and in the earlier publication of the present writer<sup>7</sup> referred to, yields photographs in which no part of the photographing mechanism appears, and in which the bullet is not touched in any way.

#### ACCELERATION OF PROJECTILES AFTER LEAVING MUZZLE.

Opinion appears to be prevalent that a projectile continues to be accelerated for a considerable distance after leaving the muzzle of the gun. Thus John W. Hicks in his book, "The Theory of the Rifle and Rifle Shooting" (1919), quotes Dunn of the Ordnance Department, U.S.A. (1897), as saying: "Small arm bullets should be considered as having their maximum velocity at points from 20 to 30 feet in advance of the muzzle. They should gain in velocity over this distance for the bullet is enveloped in gases moving in the same direction and with higher speed than that of the bullet. . . ." No refutation of this view has been found in the literature. Photographs taken during the course of this investigation indicate, on the other

hand, that the service projectile of a calibre 0.30 Springfield rifle ceases to be accelerated within a foot of the muzzle. Such a photograph is shown in Fig. 2. The muzzle of the rifle does not appear in the photograph, but, from measurements made at the time the photograph was taken, it is known that the centre of the plate was eleven inches in advance of the muzzle. It will be seen that the bullet is already well in advance of the outermost boundary of the propelling gases, and since the bullet has set up its normal head wave, it is subject only to the retarding forces considered in exterior ballistics.

Other photographs, taken of a bullet four or five inches in advance of the muzzle, show that in this

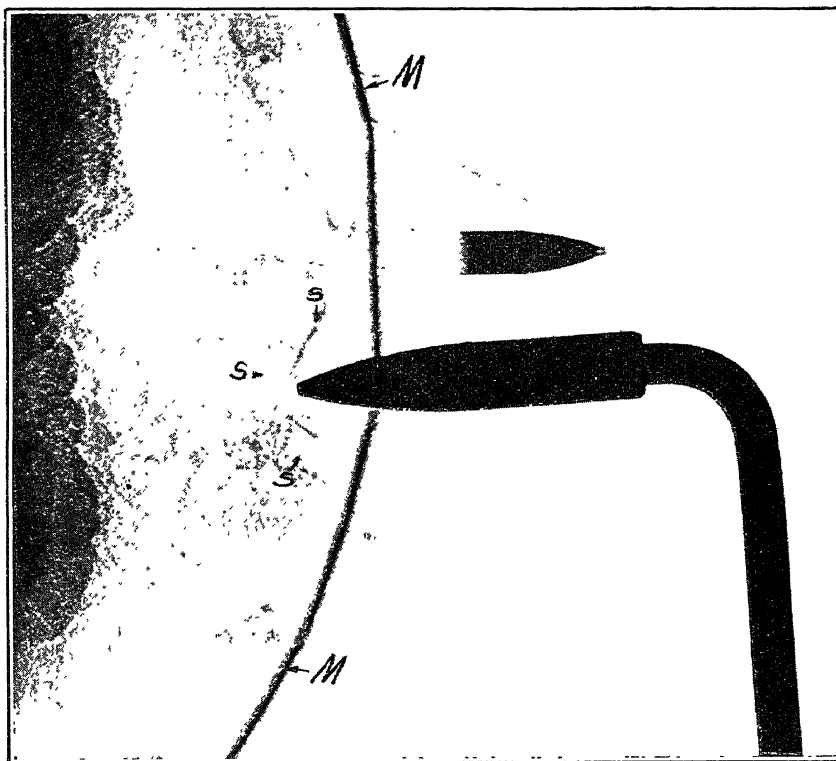


FIG. 4.—Stationary projectile within the boundary wave M sets up an ordinary sound wave S.

position the powder gases are being deflected from the base of the bullet and consequently the bullet is being accelerated. At a distance of from six to eight inches in front of the muzzle the speed of the powder gases falls below that of the bullet, and at a distance of eleven to twelve inches the bullet has outdistanced all the blast effects, with the possible irrelevant exception of a few stray powder particles, and cannot be overtaken by any accelerating forces of the discharge.

Fig. 3 shows one of a series of fifteen photographs taken of the discharge of a 0.45 calibre double action revolver, model of 1909. In this photograph the bullet is about 1¼ inches in front of the muzzle. The bullet is still being accelerated, since the propelling gases are being deflected from its base. Other photographs show that for this particular arm and ammunition the bullet ceases to be accelerated within a distance of 6 inches from the muzzle. Phenomena such as those depicted in these photographs are not to be considered

as representing a random distribution of the powder gases of the propelling charge which have been recorded by a fortunate exposure of the plate. They are, on the contrary, perfectly definite stages of a cycle which repeats itself over and over again for the same arm and powder, and any particular stage of the phenomenon can be duplicated within narrow limits.

#### GAS MOTION AT THE MUZZLE.

The photograph shown in Fig. 2 possesses features of interest in addition to its bearing on the acceleration of the projectile. Let us consider the state of the gases inside the boundary wave  $M$ . It will be seen that the head wave of the bullet does not extend rearward beyond the wave  $M$ . The absence of this wave inside

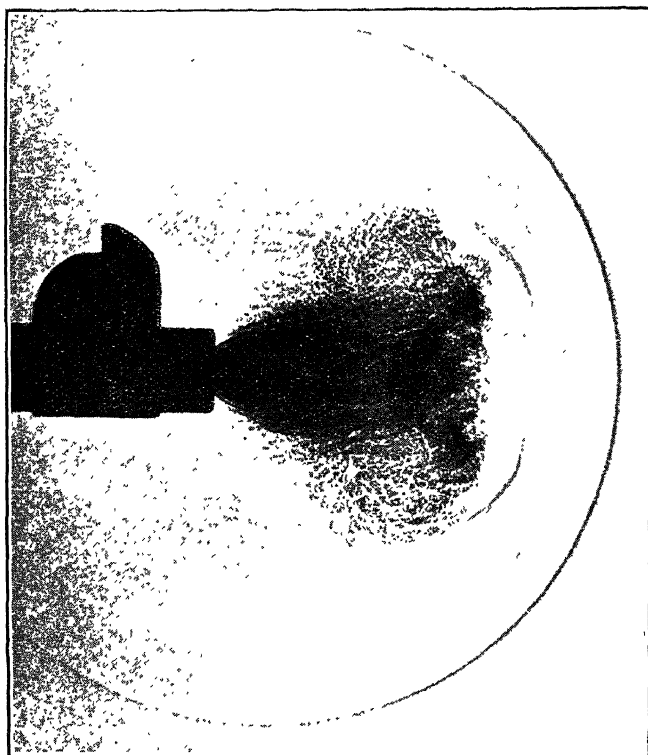


FIG. 5.—Gas leakage from a .30 Springfield rifle. Photograph taken before the bullet emerged.

of  $M$  is to be ascribed to the fact that in this region the speed of the projectile relative to the gas is less than the speed of sound in the gas, for otherwise a head wave would be formed. It therefore follows that the gases behind this wave are moving forward at considerable speed, or that the speed of sound in this medium is quite high, or that a combination of these conditions exists.

If the absence of the head wave, above mentioned, is due to the forward motion of the gases inside the wave  $M$ , a stationary projectile set up in this region should show a head wave pointing in the direction from which the gases are coming, providing that their speed is above that of sound in the medium. However, the actual experiment, the result of which is shown in Fig. 4, showed no such wave at the nose of the stationary projectile and therefore  $G$ , the speed of the gases, is less than the  $S_0$ , the speed of sound in them. How-

ever, when this fixed projectile pierced the wave  $M$  it started an ordinary sound wave  $S$  which at the moment it was photographed had attained a diameter as measured on the plate of 1.44 inches. We may assume that the centre of this wave was originally at the point of the bullet, but a pair of compasses will show that its centre is now displaced about 0.38 inch, and that it is practically undistorted. This absence of distortion of the spherical wave while its centre has been moved 0.38 inch indicates reasonably uniform motion of the medium in which it is propagated. Furthermore, if the gases inside the wave  $M$  were moving forward with the speed of sound in the medium, then the portion of the spherical sound wave nearest the muzzle could not move from the point of the projectile at which it started.

If, on the other hand, the gases were stationary, the wave would expand, keeping the point of the projectile as a centre. The actual case is somewhere between these two. While the sound wave has moved out until its radius is approximately 0.72 inch, it has been moved forward as a whole 0.38 inch; hence the forward speed of the gases must be  $0.38/0.72$  or 0.53 that of the speed of sound in the gases.

From the relative positions of the moving projectile and wave  $M$ , it follows that the average speed of the projectile is slightly greater than that of the wave  $M$ , assuming that the base of the projectile and the wave left the muzzle at very nearly the same time. If we also assume that the speed of the wave  $M$  has not increased, then since we know that the speed of the bullet has increased somewhat above its mean speed, it follows that the present speed  $P$  of the bullet is greater than the present speed  $W$  of the wave. Hence the speed of the gases is something less than half that of the projectile and the speed of sound in these gases is something comparable with that of the projectile.

If in Fig. 4 we let

$$\begin{aligned} P &= \text{speed of projectile,} \\ W &= \text{,, the wave } M, \\ G &= \text{,, gases immediately behind } M, \\ S_a &= \text{,, sound in free air.} \\ S_0 &= \text{,, sound in gases immediately behind } M. \end{aligned}$$

The arguments just presented may be summarised as follows:

$$\begin{aligned} G &= \frac{1}{2} S_0, & (1) \\ S_0 &= W, & (2) \\ P &> W. & (3) \end{aligned}$$

The condition that no head wave shall exist behind the wave  $M$  is

$$P - G < S_0, \quad (4)$$

or in view of (1) and (2)

$$P < \frac{3}{2} W. \quad (5)$$

But it was found from the relative positions of the wave front  $M$  and the projectile that  $P$  is only slightly greater than  $W$ . It therefore follows that condition (5) is satisfied and the absence of the head wave in the region behind  $M$  is accounted for.

## GAS LEAKAGE.

Since the first introduction of firearms, a leakage of the gases of the propelling charge past the projectile has represented a great waste of the available energy. Little could be done to reduce this loss in the case of

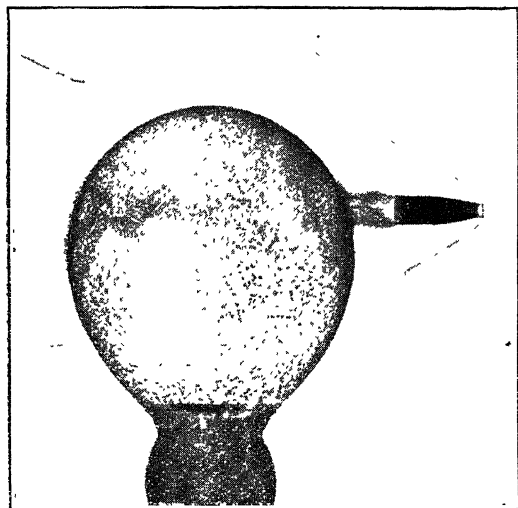


FIG. 6.—0.30 calibre projectile after passing through a bubble containing a mixture of hydrogen and air. The head and base sound waves are considerably modified.

the smooth-bore and rifled muzzle loaders in use up to half a century ago. The projectile could not be made to fit the bore too snugly since the ball and its accompanying wad could not then be forced down upon the powder charge; and when the size of the ball was so reduced as to make loading at the muzzle feasible, the fit was at best rather poor.

With the introduction of the breech loader and fixed ammunition, the first real step towards reducing gas leakage was achieved. In these arms the cartridge fits nicely into a breech chamber, the forward end of which leads by a short cone to the lands and grooves of the rifling. In the case of a lead bullet, the metal is suddenly forced into a rifled tube having a diameter (measured between lands) slightly smaller than that of the projectile, so that the soft metal is forced into the grooves making a seal to which the older arms could never approximate. The improvement is, however, a relative one, since gas leakage is still present in the best arms of to-day, though, of course, on a greatly reduced scale.

Fig. 5 shows the gas leakage which accompanies the firing of a 0.30 calibre Springfield rifle. The photograph was taken before the bullet emerged from the muzzle, and the dark mass of gas in front of the muzzle consists largely of powder gases which have leaked past the projectile. The heavy black spherical wave which forms the envelope of all other disturbances produced by the discharge originated with the unseating of the bullet from the cartridge case. The resultant pulse or compression wave passed down the rifle tube and travelled outward from the muzzle.

## MODIFICATION OF SOUND WAVES BY THE MEDIUM.

The explanation, by C. V. Boys, of the formation of the sound waves which attend the motion of a pro-

jectile makes it clear that the regular head and base waves cannot be formed unless the speed of the projectile is equal to or greater than the speed of sound in the medium. Since the speed of sound in hydrogen gas is considerably greater than that of the service projectiles, it follows that a projectile entering a soap bubble filled with hydrogen gas should lose its head and base waves, which should reappear when the projectile emerges into the air. These conclusions have been fully confirmed from photographs which have been taken at the Bureau of Standards with the apparatus described in this paper.

Fig. 6 shows a 0.30 calibre projectile after passing through a soap bubble filled with a mixture of hydrogen and air. In this photograph, the sound waves attending the projectile have been considerably modified in form due to travelling for a time through a medium in which the speed of sound was considerably greater than that of air.

## TRACER BULLETS.

Fig. 7 is a photograph of a tracer bullet taken approximately 35 ft. from the muzzle. It appears to have been generally believed that the strong light which tracer bullets emit would make it impossible to photograph them successfully, and visual observation tended to confirm this belief. This photograph was obtained by using a rectangular tube of black paper with its axis at right angles to the trajectory and coincident with the

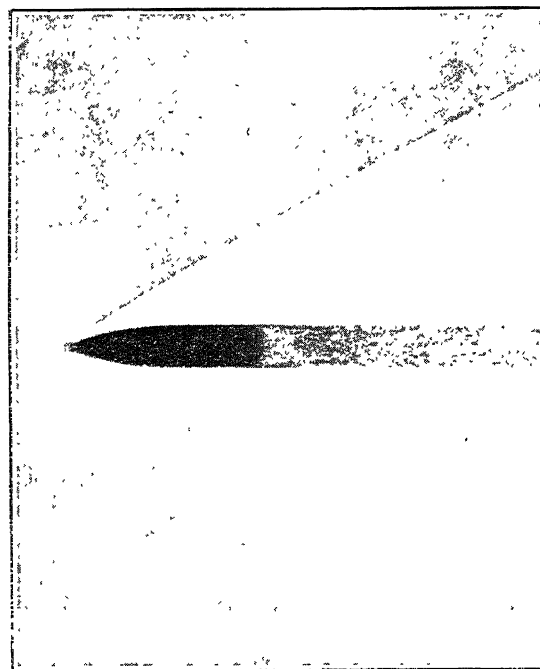


FIG. 7.—Tracer bullet approximately 35 ft. from the muzzle. The base wave is almost completely absent.

line joining the spark gap and the centre of the photographic plate. By this device the plate was shielded against the tracer light before and after the bullet had traversed the tube. The plate is fogged, of course, but it nevertheless shows some interesting details.

The most striking thing is the almost complete absence of a base wave. The usual base wave is undoubtedly associated with the rapid pressure drop at

the base of the projectile. Apparently the gases generated by the tracing compound prevent the formation of a region of diminished pressure, and hence the formation of a base wave. About two inches back from the base of the tracer bullet, particles of the tracing compound can be seen as they leave the wake.

In conclusion, the author wishes to express his indebtedness to Dr. E. A. Eckhardt for suggestions and assistance in the experiments and in the preparation of the manuscript, and to Drs. L. J. Briggs and E. Buckingham for their kindly interest in the experiments and their helpful suggestions and criticisms.

The courtesy of the Frankford Arsenal in furnishing some of the arms and ammunition is gladly acknowledged. Most of the photographs here presented were taken in the process of developing the design of bullet photography apparatus for the use of that organisation.

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### Hindu Astronomy.

THE study of the origin and progress of Indian astronomy has attracted a good deal of attention among Orientalists and historians of astronomy during the last 140 years, and has given rise to a considerable amount of controversy, which now seems to have ceased, at least among competent scholars. The history of the literature of the subject down to 1893 was written by the late James Burgess (*Journal of the Royal Asiatic Society*, October 1893) and need not detain us here. While during the last seventy years critical editions and commentaries of the Siddhāntas or text-books have finally silenced the opponents of the connexion between the later Hindu astronomy and that of the Alexandrian Greeks, attention has also been directed to the earlier Vedic and post-Vedic periods. But a general account of the subject in the English language was wanting, and this has now been supplied in a valuable memoir by Mr. G. R. Kaye,<sup>1</sup> who had already published several minor papers on Indian science, and an exhaustive monograph on those strange aftermaths of Muslim astronomy, the great masonry instruments of Jai Singh.

The earliest sacred works of the Hindus, known as the Vedas, contain astronomical references of interest, and there is from the post-Vedic period a formal work on astronomy, the *Jyotisha Vedāṅga*, which claims by its title a fairly close connexion with the Vedas. The knowledge of astronomy in the Vedic period was very scanty; the year had 360 days, with an occasional intercalary month, not clearly defined; the ecliptic was divided into 27 or 28 nakshatras or lunar mansions. The Vedic seers must have had some knowledge of the planets, yet there is no explicit reference to them in any of the Vedic writings, though it is possible that in the *Rigveda* Jupiter is meant by *Brihaspati*, by which name the planet was known later on. In the post-Vedic period (about 400 B.C.—A.D. 200) we find a five-year cycle of  $5 \times 366$  savana or civil days. The nakshatras are nowhere in these early works definitely connected with particular stars or constellations. Attempts have been made to assert that the early Hindu writers had knowledge of the precession of the equinoxes, but as their year was 18 hours too long, and their methods of observing were very crude, they could not possibly have anticipated the discovery of Hipparchus, which even the Babylonians, notwithstanding their accurate knowledge of astronomical periods, were unable to do.

About the fourth century A.D., however, a very great

change took place in the Hindu astronomical teaching. As we have already remarked, no European scholar now doubts that the new teaching was solely due to Greek influence, and only some Indians, influenced by sentiment, continue to deny it. The Greek kingdom of Bactria had come to an end in the first century B.C., but a revival of intercourse between India and the West certainly began in the second half of the fourth century and was continued by Nestorian missionaries, who from Persia wandered all over the East. Our principal sources of information about the new science are the *Aryabhatīya* of *Aryabhaṭa* (composed in A.D. 499), *Varaha Mihira's Panchasiddhāntikā* (about A.D. 550), a similar work by *Brahmagupta* (about A.D. 630), and the *Sūrya Siddhānta*, which in the form now extant is later than A.D. 1000, but is founded on a much older original. *Albiruni's* celebrated book on India (A.D. 1031) is also a valuable source.

The first glance at one of the *siddhāntas* shows the Greek origin of the contents. Greek words connected with geometry, astronomy, and astrology have been transferred into Sanskrit books with very little modification; thus horizon became *harija*, diametron *jamitra*, trigonon *trigona*, *lepte liptā* (a minute of arc), *kentron kendra* (also as meaning the arc of the excentric from the apogee to the centre of the epicycle), and many other terms. The *nakshatra* divisions of the zodiac were almost altogether superseded by the signs of the zodiac (previously unknown in India), and here again their origin is betrayed by their names: *Kriya*, *Tāvuri*, *Jituma*, *Karkin*, *Leya*, etc., are clearly nothing but *Krios*, *Tauros*, *Didymos*, *Karkinos*, *Leon*, etc., though later works also use translations of the Greek names. But even more remarkable is the fact that the motions of the planets, which formerly had been completely ignored, were now dealt with in considerable detail, and altogether by Greek methods, adopting the theories of excentric circles and epicycles developed in Alexandria. Everything in the *siddhāntas* is borrowed from that seat of learning. Parallax and methods of calculating it were described, and it was shown how to calculate eclipses, a subject quite new to Indian works. The length of the year was properly determined and various problems of spherical astronomy were solved.

There are some details of the Ptolemaic theory of planetary motion, which are not found in Hindu astronomy, namely, the equant or centre of equal motion different from the centre of equal distances, and certain complicated details in the theories of the moon and Mercury. It looks as if the date of the

<sup>1</sup> *Memoirs of the Archaeological Survey of India*, No. 18. "Hindu Astronomy," by G. R. Kaye (Calcutta, 1924, 134 pp.).

original work, which was introduced into India about the fourth century, was somewhat anterior to that of Ptolemy (A.D. 140), and this seems also to be indicated by the treatment of precession as a mere libration of the equinoxes. On the other hand, the apparent deviation of the epicycle from the circular form (which is not found in Ptolemy's work) may possibly be

derived from an earlier attempt to represent what Ptolemy accounted for by the equant. Thus, Alexandrian astronomy at the very time when the knowledge of it became extinct in the West, and long before the Arabs revived it in the East, was transplanted to India, though not quite in the perfect form in which it was handed down to us by Ptolemy. J. L. E. D.

### Obituary.

#### VISCOUNT LEVERHULME OF THE WESTERN ISLES.

THE death on May 7 at the age of seventy-three of Lord Leverhulme deprives the world of a man quite out of the ordinary. Possessed of an amazing vitality, which increased rather than diminished as the years passed, he exerted an influence that will be missed more than a little. For the greater part of his life his activities were confined to the building up of his own business: it is only more recently, with the conduct of the details left in the hands of competent lieutenants, that he has played a part in the affairs of the world at large. Primarily a salesman by nature, Lord Leverhulme had an intimate knowledge of every detail of the soap business; as a designer of a works he can have had few equals—indeed, to play the architect was one of his chief recreations. The great factory at Port Sunlight and the smaller plants which are growing up all over the world will for many years be memorials of this phase of his greatness.

Lord Leverhulme encouraged his technical staff in every possible way to keep abreast, if not ahead, of the times and spent large sums on original research both scientific and technical, himself taking the greatest personal interest in every detail of their progress, as exemplified by his practice of reading and making pertinent comments on every technical report sent to him. He was intensely interested in everything that concerned the betterment of the worker and was one of the very earliest pioneers in what is now coming to be regarded as the science of industrial psychology—the provision of educational facilities for the worker and his children played a large part at Port Sunlight village. Lord Leverhulme had little time to take any active part in higher education, though at times he was a generous patron of the University of Liverpool. His most generous gifts to the nation were latterly connected with art.

Lord Leverhulme was selected to deliver the Messel Lecture of the Society of Chemical Industry at the Liverpool meeting last summer, when he gave an address of prime importance and full of literary charm which in course of time will rank as one of the most remarkable testaments of ideals ever made by an industrialist. The great soap industry with all its ramifications—the Lever Brothers organisation—which he built up, replacing empiricism by science and scientific method, though leaving craft where craft meant quality, is his memorial: he himself would wish for no other.

WE much regret to record the death on March 10, at the age of fifty-six years, of Prof. John F. Hayford, whose passing has been the occasion of appreciative accounts of his life and work in several American

scientific journals. John Fillimore Hayford was trained as a civil engineer at Cornell University and was appointed computer to the United States Coast and Geodetic Survey. During this time he served on the International Boundary Commission of the United States and Mexico. In 1895 he went to Cornell University as an instructor in civil engineering, but in 1898 he returned to the Coast and Geodetic Survey, where he remained as inspector of geodetic work and chief of the computing division until 1909. In that year he went to Northwestern University, Illinois, as director of the newly organised College of Engineering. While there he investigated on behalf of the Carnegie Institution of Washington the problem of the surface levels of the Great Lakes and the causes of their fluctuations. Hayford is best known, however, for his computation of the dimensions of the earth, or the Hayford spheroid, based on the theory of isostasy, which was accepted at the recent Madrid meeting of the International Geodetic and Geophysical Union. His work on isostasy was also acknowledged last year by the award of the Victoria Medal of the Royal Geographical Society.

PROF. GUGLIELMO KÖRNER, who died recently in Milan at the age of eighty-six years, was a native of Cassel. After extensive travels in European countries he became professor of chemistry at the Royal High School of Agriculture at Milan, remaining in that capacity for forty years. His work on the constitution of pyridine and quinoline and on the orientation of derivatives of benzene is well known. He was the Davy medallist in 1900 of the Royal Society, and an honorary fellow of the Chemical Society.

IN *Nature* for March is a notice by A. E. Træen of Dr. Barthold Hansteen Cranner, professor of botany at the Agricultural College in Aas, Norway, who died on February 2, at the age of fifty-eight. Cranner was best known for his work on the biochemistry of the cell-wall in plants.

WE regret to announce the following deaths:

Prof. Albin Haller, For. Mem. R.S. and Davy medallist, and honorary fellow of the Chemical Society, director of the Municipal School of Physics and Chemistry in Paris and professor of organic chemistry at the Sorbonne.

Prof. C. D. Woods, director from 1896 until 1920 of the Maine Agricultural Experiment Station, and since then director of information of the Massachusetts Department of Agriculture, who made noteworthy contributions to our knowledge of the nutrition of plants and animals and of foodstuffs generally, on March 30, aged sixty-eight.

## Current Topics and Events.

ON Saturday last, May 9, the British Empire Exhibition at Wembley was reopened by the King amid scenes of much popular enthusiasm. The King was accompanied by the Queen and was received by the Duke of York, who is president this year of the Exhibition. In his address inviting the King to open the Exhibition, the Duke of York emphasised the many benefits which have resulted from last year's display and stated that, while the Exhibition of 1925 "has integrally the same purpose as in 1924—to show how great are the resources available within the Empire . . . it will present its lessons of Empire in a new manner." In a happy phrase, he referred to the Exhibition as the "University of Empire." The King congratulated the president, the board of management, and the executive council of the Exhibition on the results of last year's work, and again the educational side was brought out when the King, speaking of the importance of goodwill between the peoples of the British Empire, declared that "the one sure foundation for that goodwill is a full knowledge of our mutual aspirations, capacities, and needs. To seek knowledge, more knowledge, and again more knowledge, of the great heritage which has been entrusted to us is the soundest Imperial policy." As last year, the opening ceremony in the Stadium was broadcast from all the stations of the British Broadcasting Company. The general features of the Exhibition will be familiar to most readers of NATURE, and we hope in future issues to deal in detail with specific scientific aspects such as the display illustrating physical and biological science arranged by the Royal Society, the pure chemistry section which the Association of British Manufacturers has organised, and so on.

THE Salters' Institute of Industrial Chemistry, which was founded by the Salters' Company to further the interests of industries with which it is historically connected, has now been in existence for seven years, and during this time, under the successive directorships of Dr. M. O. Forster and Prof. Arthur Smithells, it has been very successful in assisting the education of those destined for the career of industrial chemistry. For the first few years of its existence, the Institute devoted itself to helping students whose chemical training had been interrupted by the War, now it is following the policy originally laid down, namely, of awarding fellowships, of the normal value of 250-300*l.* per annum, to those who have obtained an honours degree at a university, or the equivalent, and have had a little experience of research; and of giving grants-in-aid to young men or women employed in chemical works for the purpose of continuing their chemical studies. It is interesting to note that in the award of fellowships, academic distinctions and purely mental attainments are not taken as the sole criteria of eligibility. Those conversant with the conditions in industrial works know well how often the academic man fails either because he has little or no power of applying his knowledge, or because he lacks the ability to co-operate with

those whose mental or social level is different from his own; and we wish the Salters' Institute every success in its endeavour to supply the chemical industry with men of character as well as of intellectual attainment.

THE Bolsheviki commercial publication in England, the *Soviet Union Review*, in its number for April 25, has published a formidable list of scientific institutions, learned societies, museums, etc., in the R.S.F.S.R., which means the Russian Soviet Federation of Socialist Republics, and is the overwhelmingly dominant partner in what is known as the S.S.S.R., the Soyuz (Union) of Soviet Social Republics, which in turn corresponds to what we have always known as the Russian Empire, though shorn of Finland, the Baltic States, its Polish provinces, and Bessarabia. The catalogue includes 21 institutions connected with the Academy of Sciences in Leningrad, 15 physico-mathematical institutions, 12 physico-scientific, 6 biological stations, 7 physico-historical and mathematical research institutes, 4 concerned with political economy and culture research, 4 with scientific research pedagogic institutes, 6 for social study, 11 scientific libraries, 6 scientific societies in Moscow, 9 in Leningrad and 13 in the provinces, 25 regional societies, a substantial catalogue of museums and 6 State Nature preserves. The object is evidently to show the work the Bolsheviks are doing in the arts and sciences, and a certain amount of credit must be granted to Lunacharsky, Commissar of Education, for his protection. But the vast majority of these institutions existed in tsarist days; only their titles have been altered. Novelties are the institutes for the promotion of Bolshevism, such as the Institute of Red Professors in Moscow, the chair for the study of Marxism at Kazan, and the Marxist Society in Leningrad. The museums have been enormously enriched in material and multiplied in number by the confiscation of private collections and conversion of aristocratic palaces into museums. But the article throws no light upon the efficiency of these institutions. It is known that the serious workers are hampered by incessant interference, and the financial grants, generous enough on paper, are ludicrously inadequate in fact. Thus, a grant of 130,000 gold roubles for the maintenance of one of the big scientific institutions was made and properly confirmed, but of this only 3000 roubles reached the treasurer, so that it exists to-day entirely upon the very high admission fees, which the workers of the proletariat have to pay if they want to see the museums. Truly, in Russia, "the man who holds the honey-pot licks his fingers," as the Turks say.

ARRANGEMENTS have been made by the American National Geographic Society, in co-operation with the Smithsonian Institution of Washington, to establish a station at some convenient spot for the purpose of making daily observations of the solar constant of radiation over a period of four years. An expedition, of which Dr. C. G. Abbot (director of the Astrophysical Observatory of the Smithsonian Institution)

will be the leader, will be sent out to the station chosen in order to make the necessary observations. Sites in Baluchistan, South-west Africa, and Morocco have already been selected for inspection. The project has arisen as the result of certain conclusions drawn by Dr. Abbot and his assistants—from their refined observations of the solar constant for several years past—with regard to the dependence of terrestrial weather on changes in solar radiation. It is hoped that the observations will assist in solving the problem of long-range weather forecasting. The National Geographic Society has set aside the sum of 55,000 dollars for the purpose of the expedition.

DR. ALES HRDLICKA has left Washington in charge of a survey of the field of early man and his predecessors in Southern Asia, Java, Australia, and Africa by the Smithsonian Institution in co-operation with the Buffalo Society of Natural History. The object of the expedition is to examine personally all traces of ancient man and his predecessors in these localities. In India, Dr. Hrdlicka will endeavour to examine all collections of Palæolithic implements as well as all other specimens relating to ancient man and extinct sub-human forms. He expects to visit the Siwalik Hills and also two or more of the most important centres of the non-Aryan Indian population. In Java the localities of the finds of the now known representatives of the early man *Pithecanthropus* will be visited. In Australia, Dr. Hrdlicka expects to examine the fossil Talgai skull and other skeletal remains of the Australian aborigines. In South Africa an effort will be made to visit the sites of the find of the Rhodesian man, of recent finds of fossil anthropoid apes and of prehistoric human skulls preceding the Bushman and Negro.

AN expedition under the leadership of Dr. D. B. Macmillan is leaving for the Arctic regions at the end of June under the auspices of the National Geographic Society of Washington. The first aim of the expedition will be to examine the ruins of the old Norse settlements in Greenland around Julianehaab and Godthaab, comparing these with ruins found on the coast of Labrador. It is hoped by this means to prove or disprove the Norse settlement of Labrador. From Godthaab the expedition will sail for Etah, which should be reached early in August. Here a base will be made for exploration by amphibian aeroplanes of the Greenland ice cap, Ellesmere Land and Grant Land. From Etah, oil and other supplies will be carried by air to a second base at Cape Thomas Hubbard on the north of Axel Heibergland, a distance of about two hundred and fifty miles. This base will be used for an aeroplane reconnaissance of the unexplored area of the Arctic Ocean lying between the Canadian Arctic Archipelago and the New Siberia Islands. The distance to the centre of this unknown area is about six hundred miles, and Dr. Macmillan hopes to cover the double journey in a continuous flight. If any islands are discovered, a landing will be made. On the completion of this ambitious programme in the north, the expedition will go southward along the eastern shores of Ellesmere

Land to Bylot Island, which will serve as a base for the aeroplane exploration of Baffin Land. Lastly, Nachvak Bay will serve as a base for flights over northern Labrador. Meteorological observations of the upper air will be taken during all the flights. It is expected that the expedition will be away until the autumn.

A COMMUNICATION in the *Times* of April 28 describes investigations carried out last year by Prof. Hrozny in Syria and Asia Minor with the object of throwing light on Hittite problems. Prof. Hrozny, who is well known to scholars for his researches in the Hittite language, which led to the discovery of its Indo-European affinities, has planned a series of excavations on sites on the borders of the Hittite Empire in the hope that the discovery of a bilingual inscription may lead to the decipherment of the Hittite pictographic script. Excavations at Sheikh Sa'ad in Bashan near the monolith of Rameses, called by the neighbouring inhabitants "the Stone of Job," revealed an Amorite shrine of a deity Arkan Saphon, which was the centre of a widespread cult. This cult, as was shown by the later Hellenistic shrine, was adopted by the Greeks. It was surrounded by a number of edifices and remains ranging from the Hittite period in the Second Millennium B.C. down to the Roman times. It is clear that the inhabitants were Amorites who were affected by Hittite culture, and possibly under Hittite rule. The site may mark the frontier of the Hittite Empire. A projected excavation at Kaisarieh in Anatolia could not be carried out, but the hitherto unknown source of the well-known Cappadocian tablets was identified at Kul Tepe.

DR. H. H. DALE, in his discourse at the Royal Institution on May 8, on the circulation of blood in the capillary vessels, said that about the year 1917 evidence from several independent quarters began to appear, necessitating an extensive revision of the older conception of the capillaries as playing a purely passive rôle in the regulation of the blood flow. Ebbecke in Germany, and Lewis and his co-workers in Britain, began to publish evidence that the capillaries are capable of closing completely by their own contractile force. In the following year Krogh, of Copenhagen, showed that, in the muscles at rest, only a very small part of the rich network of capillary vessels is open for the passage of blood, the remainder being completely closed by their own contractile tone. Meanwhile similar conclusions had been reached by another independent group of investigators, including Dr. Dale, who were studying the collapse of the circulation produced by a group of substances resulting from the decomposition of proteins, a typical member being the base histamine. Such substances caused relaxation of the peripheral blood vessels, apparently largely of the capillaries. When the effect was intense, a large part of the blood passed out of circulation, becoming stagnant in the generally relaxed capillary vessels, and losing a large part of its plasma through their permeable walls. The deduction was made, and almost immediately

confirmed by Krogh's direct observations, that the capillaries possess a power of independent contraction, by which a large proportion of them are normally closed. These conceptions have acquired increasing importance, not only for the understanding of the fine adjustment of the blood-flow to the varying metabolic needs of the tissues, but also in explaining a number of pathological conditions, where, as the result of massive injury of the tissues, or of the invasion of the body by bacteria, poisonous protein derivatives are distributed in the circulation producing in a generalised and dangerous form a relaxation of the capillary vessels, which, in the form of a localised inflammation, is protective and restorative. There is evidence that the internal secretions of the suprarenal and pituitary glands have an important effect on the tone of the capillary vessels.

THE first Fison Memorial Lecture was delivered by Sir Joseph Thomson in the Medical School, Guy's Hospital, London, on Thursday, May 7, the chair being taken by Lord Balfour. Sir Joseph selected as his subject "The Structure of Light," in the course of which he stated that the optical properties of light appear to be explicable only upon a wave theory, whereas the electrical properties are more easily explained on a corpuscular theory. Newton himself really combined the two theories, as the assumption of waves generated by the corpuscles was an essential part of his explanation of simultaneous reflection and refraction. The followers of Newton were "more corpuscular" than Newton himself, and a purely corpuscular theory of light was generally adopted until the work of Young and Fresnel once more focussed attention upon the wave theory. By the end of the nineteenth century, Maxwell's electromagnetic theory, and the pioneer experiments of Hertz and Lodge on electromagnetic waves, had made the wave theory of light probably the most complete and satisfactory in physical science. Then the study of gaseous ionisation, the photo-electric effect, X-rays and black body radiation, began to throw doubts upon the sufficiency of the ordinary wave theory.

As an alternative, Sir Joseph Thomson put forward a new theory designed to explain both electrical and optical properties of light (see *Phil Mag.*, vol. 48 (1924), p. 737). Imagine an electron and a positive nucleus joined by a tube of force. If the electron jumps from one stable state to another of smaller energy, we may suppose that the tube of force is thrown into a loop, which becomes detached as a closed "ring of force." Such a ring would travel out like a vortex ring in a direction perpendicular to its own plane. It would also carry with it a definite "quantum" of energy. Immediately before and after the formation of the ring ordinary electromagnetic waves would also be started, but the ring would carry nearly all the energy liberated by the movement of the electron. Absorption of energy by an atom could take place by a converse process, and would normally occur only when the energy in the ring was sufficient to move an electron from one

stable state to another, *i.e.* when the energy was great enough to produce partial or complete ionisation of the atom. The circumference of a ring of force would be equal to the wave-length of the light, and so a ring of visible light would be too large to be absorbed easily by an atom except by a process involving resonance, whereas an X-ray ring would be comparable in size to an atom. This would account for the observed differences between X-ray and optical absorption. The waves which accompany the ring would undergo interference and diffraction, and the rings would tend to follow the waves, so that the probability of a ring reaching a given point would depend upon the amplitude of the wave at that point. Thus interference and diffraction fringes would be statistical effects.

THE eighth lecture of the series on "Physics in Industry" being given under the auspices of the Institute of Physics was delivered by Dr W. Makower on April 29 and dealt with "Physics in the Rubber Industry with special reference to Tyre Manufacture." In this industry there are many stages where the skilled assistance of the physicist has proved valuable in improving the product or in reducing costs. In testing the raw material, hardness is the decisive quality and this is determined by viscosity measurements, made by forcing the rubber at a constant temperature of 80° C. through an orifice and measuring the rate of flow. In all properties related to hardness, temperature is a most important factor. Thus, rubber must be stored at a low temperature and processes such as calendering and rolling must be carried out at constant temperatures, to which end thermocouples are now used extensively. To measure the physical effects of addition agents on hardness, it is usual to construct stress-strain diagrams. In vulcanisation, physical control is used in determining the amount of sulphur absorbed at different depths of the tyre, thermocouples being embedded in it and the temperature attained noted. The way the tyre is built up will determine largely its ultimate strength, which is found chiefly to depend upon that of the cotton case. Other necessary tests are for fatigue and abrasion, and these have to be so designed as to imitate the effects of actual practice. Of great interest are the hysteresis heat losses, which may amount to one-half to one H.P. per tyre. These depend upon the deformation of the rubber as well as on the rate of application of the cyclical stresses. In this connexion, Dr. Makower pleaded for closer co-operation between tyre manufacturers and automobile engineers so that there may be careful adjustment between springs and tyre equipment.

BROADCASTING reception in Great Britain is by no means confined to the programmes transmitted by stations in this country, and a number of continental stations can now be easily received. The Oslo station is the most recent addition, and the number will soon be increased by transmission from Stockholm and Madrid, when the stations which are now in course of erection by Marconi's Wireless Telegraph Co., Ltd., are completed. The new stations are

Standard Marconi 6 kw. Type "Q" stations, similar to those of the British Broadcasting Company's main stations. The transmitter consists essentially of four panels; rectifier; independent drive; main oscillator and modulator. The use of the independent drive in the Marconi transmitters ensures the invariability of the carrier wave frequency, with consequent absence of alteration of tuning adjustments at the receiver. One of the features of transmissions from the Oslo station so far as British reception is concerned, appears to be the absence of fading. The aerial is supported by two lattice steel masts 70 feet high and is a "T" type of four-wire cage aerial, with a span of 150 feet. The Oslo station has avoided causing interference with other European broadcasting stations by using the wave-length of 382.5 metres.

THE twelfth International Physiological Congress will be held in 1926, at Stockholm, on August 3-6. The Congress will be under the presidency of Prof. Johansson. Prof. Liljestrand will be honorary secretary, and Prof. Santesson honorary treasurer.

THE Lawes Agricultural Trust Committee has appointed as its chairman Lord Clinton, in succession to Lord Bledisloe, who resigned on accepting the post of Parliamentary Secretary to the Ministry of Agriculture and Deputy Minister of Fisheries.

DR. EMILE BRUMPT, professor of the Faculty of Medicine of the University of Paris, will deliver two Chadwick Public Lectures, on May 25 at the Barnes Hall of the Royal Society of Medicine on "How to conduct an Anti-Malarial Campaign," and on May 29 at the Royal Society of Arts on "The Prophylaxis of Sleeping Sickness."

DR. E. F. ARMSTRONG, F.R.S., technical director of Joseph Crosfield and Sons' Soapworks at Warrington, has been appointed managing director of the British Dyestuffs Corporation. Dr. Armstrong, who was president of the Society of Chemical Industry in 1922-24, is well known for his work on the chemistry of plant products and on the nature of enzymes; he has also made noteworthy contributions to the study of catalysis. His work covers a wide field in both pure and applied chemistry, and together with his administrative experience, eminently qualify him for the important post which he has now accepted.

THE Council of the Royal Society of Edinburgh has made the following awards:—The Gunning Victoria Jubilee Prize for the period 1920-1924, to Sir Joseph Thomson, in recognition of his great discoveries in physical science; and the Makdougall-Brisbane Prize for the periods 1920-1924, to Prof. H. Stanley Allen, for his papers on the quantum and atomic theory, published in the Society's Proceedings within the periods.

THE Council of the Institution of Electrical Engineers has made the following award of premiums for papers read during the session 1924-25, or accepted for publication:—*The Institution Premium*: Mr. H. W. Clothier. *Ayrton Premium*: Major E. I. David. *Fahie Premium*: Col. T. F. Purves. *John Hopkinson Premium*: Mr. G. Rogers. *Kelvin Premium*:

Lieut.-Col. K. G. Maxwell and Mr. A. Monkhouse. *Paris Premium*: Mr. D. Murray. *Extra Premiums*: Messrs. J. D. Cockcroft, R. T. Coe, J. A. Tyacke, Prof. Miles Walker, and Mr. S. Holmes. *Wireless Premiums*: Major A. G. Lee and Mr. A. J. Gill; Capt. H. J. Round and Messrs. T. L. Eckersley, K. Tremellen, and F. C. Lunnon; Prof. E. Mallett and Mr. A. D. Blumlein, and Mr. L. C. Pocock.

PROF. T. C. CHAMBERLIN, of Chicago, has been awarded the first Penrose Medal of the American Society of Economic Geologists. The Medal, which is to be given once in three years for "exceptionally original work in the earth sciences," was established by Dr. R. A. F. Penrose, jun., first president of the Society of Economic Geologists, and is of gold. We learn from *Science* that in making the award, Prof. Kemp, president of the Society, referred in particular to Prof. Chamberlin's work on the lead and zinc ores of the Upper Mississippi Valley, and to his contributions on the Ice Age, on the planetesimal hypothesis and related topics, and on diastrophism as a principle in the subdivision of geological time.

WING COMMANDER HAROLD E. WHITTINGHAM has been awarded the Chadwick Gold Medal and 100*l.* prize for his work on sand-fly fever. The award is made under the provisions of the Chadwick Trust, whereby the Trustees may, once in every five years, present the sum of 100*l.* and a Gold Medal to be called the Chadwick Naval, Military or Air Force Prize to such officer of the Navy, Army or Air Force Medical Service as shall during the preceding five years have "specially assisted in promoting the health of the men" of the Service to which he belongs.

A CONFERENCE of women in science and industry at the British Empire Exhibition, Wembley, on July 15-17, has been convened by the Women's Engineering Society in co-operation with the British Federation of University Women, Industrial Welfare Society, Institute of Industrial Welfare Workers, The National Union of Scientific Workers, The Standing Joint Committee of Industrial Women's Organisations and the Women's Electrical Association. H.R.H. the Duchess of York has consented to become president of the conference, and amongst those speaking on the opening day will be: The Hon. Lady Parsons (Engineering), and Miss Ellen Wilkinson, M.P. (Industrial Organisation). The following two days will be devoted to papers by women workers on such subjects as engineering, chemistry, industrial welfare, factory inspection and commerce. Particulars can be obtained from the Secretary, Women's Engineering Society, 26 George Street, Hanover Square, London, W.1.

A PRELIMINARY meeting of the International Congress of Radiology will be held at the Central Hall, Westminster, on July 1-4, under the presidency of Mr. C. Thurstan Holland. The Congress will meet in three sections: (1) radiology; (2) electrotherapy and physiotherapy; and (3) physics. During the meeting there will be an exhibition of apparatus and books at the Central Hall, Westminster, and an exhibition of radiograms in the British Institute of Radiology, including those relating to papers read at the Congress.

On July 1 the Duc de Broglie will deliver the Silvanus Thompson Memorial Lecture, and on July 3 Sir Berkeley Moynihan will deliver the Mackenzie Davidson Memorial Lecture, taking as his subject "The Relationship of Radiology and Surgery." Communications regarding the Congress should be addressed to the Secretaries, International Congress of Radiology, c/o British Institute of Radiology, 32 Welbeck Street, London, W.1.

FOR its May meeting the Society of Glass Technology has arranged a symposium of papers on the constitution of glass, to which a number of important contributions have been promised. Two sessions will be held, the first at 7.30 P.M. on Monday, May 25, at the Royal Society of Arts, John Street, Adelphi, London, and the second on Tuesday, May 26, at 2.30 P.M., in the Chemistry Lecture Theatre, University College, Gower Street, London. Papers have been promised by Prof. W. E. S. Turner (Sheffield), Prof. G. Tammann (Göttingen), Dr. F. Eckert (Essen), Dr. A. Q. Tool and E. E. Hill (Bureau of Standards, U.S.A.), Prof. Le H. Chatelier (Paris), Sir William Bragg (Royal Institution, London), Mr. V. H. Stott (National Physical Laboratory, Teddington), Dr. G. W. Morey and Dr. N. L. Bowen (Geophysical Laboratory, Washington), Dr. A. A. Lebedeff (Optical Institute, Leningrad), Dr. G. W. Morey and Dr. R. W. G. Wyckoff (Geophysical Laboratory, Washington). Members of the Faraday Society, the Optical Society, the Physical Society, and others interested in the subjects of discussion are invited to be present.

WE welcome the appearance of the opening part of the *Japanese Journal of Mathematics*, which is

announced to appear quarterly, sponsored by the National Research Council of Japan. Ninety-three pages of Transactions contain 16 papers (of which 14 are in English and 2 in German), all in pure mathematics and nearly all on the higher analysis. There follow 12 pages of English abstracts of recent mathematical papers published in other Japanese journals. This new venture, together with similar publications already in existence or promised, covering such subjects as astronomy and geophysics, chemistry, physics, geology and geography, botany, zoology, medical science, and engineering, are likely to enhance the quality of scientific research in Japan; and if they are well distributed they cannot fail to improve the status of Japanese work in the world of science.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: an assistant in mathematics in the Queen's University, Belfast—Prof. Dixon, the University; a lecturer in agriculture at Armstrong College, Newcastle-upon-Tyne—The Registrar; a laboratory assistant in the agricultural department of the Government of Kenya—The Crown Agents for the Colonies, 4 Millbank, S.W.1; two zoologists for the *Discovery* Expedition—The Secretary, *Discovery* Committee, Colonial Office, Downing Street, S.W.1 (May 25); a junior assistant under the directorate of explosives research of the research department, Woolwich—The Chief Superintendent, Research Department, Woolwich; a biology teacher, either sex, at the Municipal Secondary School, Wolverhampton—The Director of Education, Education Offices, Wolverhampton (May 30); full-time lecturers in biology and mathematics at the Technical College, Cardiff—The Principal (May 30).

### Our Astronomical Column.

COMETS AND MINOR PLANETS.—Dr. W. H. Steavenson obtained an observation of Orkisz's Comet on May 6<sup>d</sup> 0<sup>h</sup> 1<sup>m</sup>, G.M.T. (new), R.A. 23<sup>h</sup> 15<sup>m</sup> 26.12<sup>s</sup>, N. Decl. 55° 14' 53.9", equinox 1925.0. The comet was of magnitude 7.5 and growing slightly fainter.

Owing to its high north declination it is observable all night:

EPHEMERIS FOR 0<sup>h</sup> (by Möller and Johannsen).

	R.A.	N. Decl.	log $r$ .	log $\Delta$ .
May 15.	23 <sup>h</sup> 51 <sup>m</sup> 4 <sup>s</sup>	67° 25'		
19.	0 18 23	72 24	0.129	0.184
23.	1 1 31	76 51		
27.	2 14 57	80 23	0.152	0.206
31.	4 12 18	82 11		
June 4.	6 18 19	81 36	0.175	0.235

EPHEMERIS FOR 0<sup>h</sup> OF COMET SCHAIN, COMAS SOLA (by H. Kobold).

	R.A.	N. Decl.	log $\Delta$ .
May 16.	10 <sup>h</sup> 31 <sup>m</sup> 45 <sup>s</sup>	4° 28'	
20.	10 28 27	4 29	0.604
24.	10 25 30	4 30	
28.	10 22 54	4 29	0.619
June 1.	10 20 36	4 26	
5.	10 18 37	4 22	0.634

It is of magnitude 12 and slowly fading.

*Astr. Nach.*, No. 5365, contains an important series of observations of planet TD (the interesting object discovered last October by Baade, the period of which is 4.36 years), made by G. Struve at Berlin Babelsberg, extending from November to March 3, when its magnitude was 13.0.

No. 5366 contains observations by J. Hartmann from April to July 1924 of the planet RK, which he discovered last year. Its period is five years and its eccentricity is very small. He has given it the name La Plata, after the town where it was discovered.

GRAVITATIONAL FORCES IN SPIRAL NEBULÆ.—Prof. Ernest Brown contributes a paper on this subject to the *Astrophysical Journal* for March. His aim is to see whether the observed motions can be explained without the assumption of non-gravitational forces such as those suggested by Dr. Jeans's investigations. He first analyses the motions given by Mr. van Maanen, and shows that these are by no means uniformly outward, though the latter direction predominates at points where the spiral arms are well defined. The angular velocities diminish rapidly at first, and then become nearly constant, indicating a force varying as the distance from the centre; this would be the law of force in the equatorial plane of an ellipsoid of uniform density for a particle within the ellipsoid. The suggestion is, therefore, that there is considerable concentration at the centre, and outside this an extended ellipsoid of low and nearly constant density. The orbits of the constituent particles are supposed to fall into groups of which the "arms" of the spiral are envelopes. The space density is of the order of  $10^{-15}$  of that of the sun; this gives masses of the order of  $10^8$  times the sun, assuming a parallax of 0.007", which is, however, much larger than that indicated by the recent researches of Hubble.

## Research Items.

**THE SEQUENCE OF TYPES IN STONE IMPLEMENTS IN RHODESIA**—Stone implements in South Africa exhibit two definitely demarcated periods of human habitation, one characterised by hand axes of Chellean or Acheulean type, the other by flake implements of Aurignacian facies. In many localities the hand axes are associated with flakes, some showing unmistakable evidence of design and secondary chipping; but there is no evidence whether they indicate two distinct periods. Mr Neville Jones, in vol. 54 of the *Journal of the Royal Anthropological Institute*, describes implements from Sawmills, Rhodesia, showing two distinct periods of human activity which can be differentiated by geological evidence. This is the only site in Rhodesia as yet known on which this is possible. Hand axes of pointed and oval form are found in a bed of coarse gravel on rising ground near the Umguzi River. A lower terrace resting on alluvium and largely derived from the older terrace is the site of a factory of implements made from flakes struck from pebbles of various forms of silica. Most are worked on one side only, and show an exquisitely fine retouch. By some it is thought that these latter are the work of early Bushmen, though, as a rule, Bushmen implements are smaller and lack the same definiteness in form.

**THE ORIGIN OF AMERICAN MAN.**—In the *Quarterly Review* for April, Mr. Lewis Spence surveys and discusses the evidence bearing upon the origin and antiquity of man in America. His conclusion is that the New World received its main human stock from Asia at a period when the Eastern portion of that Continent had developed only a slender degree of culture at the closing stages of the glacial period or possibly at one of the recurring intervals of mildness; but there were later accessions. European influence, apart from the Norsemen, may be seen in the banner stones and the stone gouge of New England and farther north, and there is also the tradition of Madoc's expedition from Wales. The architectural remains of Central America and south-eastern Asia present close similarities in certain features, though the correlation of Mayan dating with our system precludes influence much later than two thousand years ago. The cult of Quetzalcoatl in his earlier forms exhibits analogies to Buddhism. Polynesian influences have been discerned in several customs and forms of artistic endeavour in South America. The extreme view of the entirely indigenous origin of American culture is untenable, but America probably was visited by a number of bands or units who brought with them the knowledge of an alien culture which only partially affected that of the older settlers from north-eastern Asia.

**RUSSIAN INVESTIGATIONS OF THE FAUNA OF ASIA.**—While expeditions of the American Museum of Natural History have been for several years exploring the past and present fauna of Mongolia, where, apparently, a large proportion of Palæarctic forms originated, the same problems have been attacked by Russian workers from the north. Prof. P. P. Sushkin made a study of the fauna of Altai mountains and of northern Mongolia during his expeditions in 1912 and 1914, results of which were so rich that he has only recently been able to arrive at some conclusions published in the recent issue of the *Comptes rendus* of the Russian Academy of Sciences. An analysis of the present ornithological fauna, in connexion with the geological history of the country, enables P. P. Sushkin to reconstruct the history of the fauna in the

following way. In the palæolithic, the Eastern, or Trans-Yenisseian, Siberia formed a continuous mass of land together with Mongolia (the Angara-continent of geologists), while the Bering Sea was covered by sea. The ancient endemic elements which are numerous in the eastern Siberian fauna are relics of the Angara fauna. The fauna of western Siberia is very poor in endemics, and it bears, on the whole, European characters; this results from the fact that the country became dry land only at the beginning of the neolithic, when it was populated by the animals driven from Europe by the glaciation, which began in Europe earlier than in Siberia. The glacial period in Siberia was followed by a dry and hot period when steppes and deserts extended very far to the north. After the desert period came a more moist one, continued until the present time, and it resulted in the extensive development of forests which have driven the steppe and desert forms southwards, while a few desert "islands" remained surrounded by forests. Prof. Sushkin is at present in the United States completing his studies and comparing his results with those attained by the American zoologists; he is also making arrangements for publication in English of his results in book form.

**DIMORPHISM IN EARWIGS**—Ever since the work of Bateson and Brindley on the length of the forceps in the common earwig, *Forficula*, this has been quoted as a typical case of dimorphic variability. In a posthumous paper D. M. Diakonov (*Journ. Genetics*, vol. 15, No. 2) has made an elaborate experimental and biometric study of this dimorphism, from Russian specimens living under the bark of tree-stumps. The dimorphic condition is confined to the males, and is known in several species. Other features of body-size vary continuously, but there is some correlation between body-size and length of forceps. The relative frequency of the two types, *brachylabia* and *macrolabia*, varies greatly with the conditions, and there is other evidence that these modes or types are non-inherited modifications. Under unfavourable conditions, a larger number of *brachylabia* occurs. The reaction-norm is not a linear but a more complex function of the environmental conditions. Various similar cases in plants, such as the *Zwischenrassen* of de Vries, are cited.

**GOLGI APPARATUS.**—In a summary account of the form and function of the Golgi bodies in cells, Mr. Leslie A. Harvey (*Sci. Progress*, April 1925) points out that they have now been found in practically all vertebrate tissues, and also in many tissues of invertebrates and plants. First discovered in 1898 in vertebrate ganglion cells, the demonstration of this apparatus in cells has resulted from the fact that it reduces osmic acid, and can be impregnated with silver salts—a technique developed by Cajal, Da Fano, Kopsch, and others. In many tissues it takes the form of a network of threads, but in invertebrates it is in rods or vesicles, and it has been seen in the living cell. It takes various other forms, and there is much evidence that it is concerned in secretion. Its history has also been traced in spermatogenesis, and it is believed to have a lipoid constitution. It is suggested that in the living cell it exists in the form of a system of vesicles each surrounded by a fluid membrane.

**THE VOLCANIC ROCKS OF BANKS PENINSULA.**—A petrographic and chemical study of these interesting New Zealand rocks has been carried out by R. Speight, and is described in the *Records* of the

Canterbury Museum, N.Z., vol. 2, No. 4. Most of the rocks present features which make their nomenclature and classification a matter of difficulty. According to the silica percentage they would be called basalts, and by some petrologists this classification would be confirmed by the usual presence of olivine. On the other hand, the ratio of felsic to mafic minerals would lead other authors to regard them as andesites. The plagioclase rarely affords a conclusive test, as the phenocrysts are frequently labradorite, while the groundmass feldspars are oligoclase. Petrologically, however, the rocks are much more closely related to the basalts of the Pacific Islands and the Brito-Arctic region than to the typical andesites of the circum-Pacific belt. This is shown by the high percentage of titanium dioxide and the generally under-saturated character of the lavas, and is confirmed by the association of dykes of trachyte and trachytoid phonolites. The succession of magmas in the region appears to be as follows: (a) rhyolites and andesites of Cretaceous age (these being Andean in type, and not referred to above), (b) olivine "andesites" and basalts of Middle Tertiary age; (c) dykes of trachyte and dolerite, nearly contemporaneous with (b); and finally (d) basalts, of which some are definitely alkaline, of late Tertiary or early Pleistocene age.

EVAPORATION AND TEMPERATURE CHANGES IN THE ENGLISH CHANNEL.—A paper by Mr. H. W. Harvey in the March number of the *Journal of the Marine Biological Association* describes a series of observations of temperature and salinity of the sea carried out since April 1921, at a station 20 miles south-west of Plymouth, where the depth is 70 metres. There was an inflow into the area surrounding the station of warm highly saline water during 1921, after which there have been no marked movements of water, but an irregular decrease in salinity. A diagram shows the monthly averages of the mean temperature of the whole column from top to bottom. The yearly minimum occurs in each year in March, and the maximum in September or October. From the changes of temperature from month to month is derived the net daily loss or gain of heat of a column of 0.1 square cm. cross section. From this and the solar radiation recorded at South Kensington, a calculation is made of the difference between the net gain or loss of heat and the incoming radiation. This difference is attributed to evaporation. The result arrived at is that the water gains heat from the spring to the autumn equinox, and loses heat from the autumn to the spring equinox, and that the loss by evaporation overshadows the loss by radiation, the loss due to direct heating of the atmosphere being relatively small. It is concluded that the changes in temperature of the sea were controlled to a marked extent by evaporation. A very interesting observation was that, in the absence of windy weather and consequent mixing by waves, the upper layers may be heated by solar radiation in early May, giving a shallow warm layer separated from the cold water below by a sharp surface of discontinuity. Several days of rough sea are necessary to disturb materially this distribution of temperature. It is also pointed out that in fine clear weather with only light winds the upper inch or two of water become very hot. The normal method of sampling sea water in a bucket represents the surface 6 inches, more or less, so that the sample is considerably cooler than the actual surface temperature of the sea. The records discussed appear to show that there is no correlation between wind during the month and either the fall in temperature or the loss of heat

due to evaporation, and it is concluded that, in the open sea, vapour pressure is the major factor controlling evaporation, and overshadows the effect of wind. It is possible that a clearer relation between wind and evaporation might have been obtained if the observations had been discussed in two separate classes, according as the air is warmer or colder than the sea surface.

MODERN COLOUR PROBLEMS.—In recent years, considerable attention has been directed to the problems involved in the perception and measurement of colour. The solution of these problems is not only a matter of academic interest, but is also of considerable practical importance. In the series of Cantor Lectures, delivered before the Royal Society of Arts on November 24 and December 1 and 8, 1924, and recently published in the *Society's Journal*, Dr. L. C. Martin gave a critical review of the present position of colour theory and standardisation. The selective effects of transmitting and reflecting materials were discussed, and the early attempts to produce artificial daylight described. Modern developments in this direction have resulted in the production of corrected units which, when properly applied, are fairly satisfactory and efficient for most of the requirements of commerce and industry. An interesting fact in this connexion is that retinal reflex actions exercise an important influence in enhancing visual sensitiveness and discrimination. Since the reflex action is much greater at the violet than at the red end of the spectrum, the deficiency in the violet in artificial daylight may be made up by a relative diminution of retinal sensitiveness, and therefore a somewhat greater intensity than is necessary in the case of real daylight may be called for if the same facility in colour matching is to be attained. In the third lecture of the series, the various methods of colorimetric measurement were described. In this branch of the subject rapid advances are being made. The study of the action of the visual receptor mechanism, its fatigue, adaptation and response characteristics, is placing the operations of photometry and colorimetry on a new and sounder basis. For the development of the more utilitarian applications of colour measurement, further study is required of the phenomenon of diffuse reflection and of the transmission and scattering of light in relation to the measurement of the surface colours of material objects.

EFFECT OF ALTERNATING MAGNETISM ON HÆMATITE.—A lecture given by Mr. W. M. Mordey to the Royal Institution on May 18, 1923, on "Some New Effects of Alternating Magnetism" has just been published. It discusses the anomalous behaviour of specular hæmatite, a black crystalline form of ferric oxide in the form of powder, when placed in an alternating magnetic field and in a rotary magnetic field. On sprinkling iron filings on a glass plate placed over an alternating current magnetic pole, the filings lie on the lines of force proceeding from a point. When, however, specular hæmatite is sprinkled on the plate a very small amount of the material is attracted to the pole, but most of it is repelled briskly in all radial directions, forming a large ring round the pole. On slightly raising the plate the small amount of attracted material is repelled to the other particles forming the ring. The particles when in a very strong field are attracted, but when in a weaker field are repelled from the pole. For a certain strength of field there appears to be neither attraction nor repulsion. The phenomenon is analogous to the electrostatic actions which take

place between two conductors having unequal but like charges of electricity. In this case, as Snow Harris showed many years ago, they attract one another when close together, but repel one another when they are far apart, the neutral position where neither attraction nor repulsion takes place being well defined. If a heap of the ore containing the hæmatite be placed on the glass plate, then the hæmatite is driven out of the heap and deposited in the feebly magnetic regions, leaving the inert material behind. When polyphase magnets are used, we get rotary magnetic fields produced, and the motions of the particles become much more complicated, especially those which exhibit strong magnetic hysteresis. The field is an inviting one for experimenters, but there are too many variables in it to make it attractive to the theoretical physicist.

**ZIRCONIUM ORES.**—The examination of a large number of zirconium ores, described by G. Hevesy and V. T. Jantzen in the *Chemical News* for March 20, shows that there is no connexion between density and hafnium content, whereas there is a rough relationship between the latter and the radioactivity. In minerals of nepheline syenitic origin (*i.e.* products of alkaline residual crystallisation) the ratio  $\text{HfO}_2/\text{ZrO}_2$  is about 0.015; in minerals of granitic origin this ratio is probably about 0.03.

**LUMINOUS PAINTS.**—An article on luminous paints and enamels is published in the *Chemical Trade Journal* for March 27. In the latter part of the sixteenth century, Vincenzo Cascariolo, a cobbler and alchemist of Bologna, experimented with some specimens of heavy spar which he obtained at Monte Paterno. On calcining the mineral with charcoal he obtained a substance "which absorbed the rays of the sun by day and emitted them by night." This power is shown by sulphides of barium, calcium, strontium, magnesium, zinc and other metals, though the actual cause of the phosphorescence is apparently the presence of minute quantities of certain impurities, which govern the colour of the glow, and in the absence of which no luminescence is observed. Highly luminous products, suitable for practical use, are now obtained by heating mixtures of alkaline earth oxides or carbonates with sulphur, to which small quantities of lithium carbonate, and in addition traces of bismuth nitrate, rubidium nitrate, lead acetate or other metallic salts, have been added. This addition is usually made in the form of a standard alcoholic solution. The article describes the manufacture of typical luminous bodies and gives several formulæ. The effective life of such substances and their practical applications are considered in full detail.

**CADMIUM.**—Dr. N. F. Budgen describes the production and commercial uses of cadmium in an article in the *Chemical Age* for March 7. The metal was first isolated in Stromeyer's laboratory from the oxide (1818); several names were proposed for it (*e.g.* melinum), but the present name, suggested by Stromeyer, was finally adopted. Cadmium is always found associated with zinc in its ores, but more recently lead and copper ores containing considerable amounts of the metal have been found. Cadmium can only be profitably produced as a by-product in the treatment of ore for the main metal, the cadmium always concentrates in the flue-dusts, condensed fumes, etc., and it is obtained from these either by direct distillation or by solution followed by chemical or electrolytic precipitation. The chemical properties of cadmium are described in detail and a good account

of the uses of the metal in alloys is given. "Stain-resisting" silver contains cadmium. The electro-deposition of the metal and its alloys is also described.

**DECAY AND PRESERVATION OF STONE.**—The decay of stone and preservation of buildings are the subjects of a paper by Dr. A. P. Laurie in the *Journal of the Society of Chemical Industry* for February 27. The rapid disintegration of stone is caused mainly by the formation of calcium sulphate crystals within it, which by persistent growth in certain layers or pockets ultimately break up the stone. Analyses of decaying stone from various cathedrals show, however, that a stone can carry considerable quantities of calcium sulphate without breaking up. The results of experiments described in the paper lead the author to propose a complete change of policy with regard to our public buildings. He suggests they should be washed down three or four times in summer so as to ensure rapid evaporation. The purpose of this is to help the rain to dissolve out as much calcium sulphate as possible. A new cement for repairing decaying stonework is mentioned, namely, "silicon ester," prepared by the action of alcohol on silicon tetrachloride. When exposed to air and moisture it deposits transparent silica. It is suggested that sandstone with a binding material of silica is most suitable for buildings in modern cities.

**GAS TURBINES.**—In a recent paper before the N.E. Coast Institution of Engineers and Shipbuilders, Mr. M. König surveys the attempts to produce a gas turbine and gives an interesting account of current work on this difficult problem. A gas turbine might compare favourably with an internal combustion engine of the ordinary reciprocating kind by an improvement in thermal economy, by a reduction in weight per horse-power, or by a reduction in harmful vibration; but in the author's view the temperatures required for high efficiency are beyond the capabilities of materials at present available, and it is only for certain specialised purposes that the second and third possible merits are of importance. Holzwarth's work on the gas turbine has for long been a source of interest to English engineers, but little was known of details of the progress which had been made. Mr. König quotes over-all efficiencies of 16.8 and 17.8 per cent. for the Holzwarth 300 kw. and 700 kw. turbines respectively, and states that a large unit of 5000 kw. at 1000 r.p.m. has been built and is now ready for testing. This large unit has a single turbine wheel of 10 ft. in diameter and 12 tons in weight. The maximum gas temperature is given as "almost 3000 deg. F." The field in which the gas turbine has won its way already to the front is in the compounding of the petrol engine used in aircraft by the employment of an exhaust turbine to pump air into the engine intake and so overcome the disadvantage of diminution in atmospheric pressure at altitude. It is stated, for example, that in January 1924 the General Electric Company of America gave particulars of such a supercharger turbine which ran at 33,000 to 41,000 r.p.m. and fed its engine, when the aircraft was at 35,000 ft. altitude, with air at sea-level pressure. The weight of this turbine plant is given as 140 lb. and the additional power delivered under these conditions by the engine as 280 h.p. The author points out that this aeronautical development may lead the way to progress in other fields, and he instances the work being undertaken in this direction by Brown, Boveri and Co., by the English Electric Co., and by the Curtis Gas Turbine Co. of America.

Recent Researches in Positive Rays.<sup>1</sup>

PROF. W. WIEN, in delivering the tenth Guthrie Lecture to the Physical Society, described the researches on positive rays carried out in his laboratory at Würzburg, passing over the subject of isotopes, as worked out in England, on the ground that this was already familiar to British audiences.

Prof. Wien dealt mainly with the determination of the mean free paths appropriate to the various states of the particles composing the positive or canal rays. Such a particle is alternately in the charged state, owing to loss of an electron by collision, and in the uncharged state, owing to the recapture of an electron in a further collision. The mean free path in the first state being denoted by  $L_1$ , in the second by  $L_2$ , the first problem attacked was the determination of the ratio  $L_1/L_2$ . It is not difficult to show that this is equal to  $n_1/n_2$ , where  $n_1$ ,  $n_2$ , are the respective numbers of charged and uncharged particles composing the stream, and it is found that  $n_1$  is less than  $n_2$ .

In the first apparatus employed, a narrow pencil of canal rays has to run the gauntlet of a series of ten condensers 1 cm. wide and separated each from its neighbour by a distance of 1 mm., the plates of each condenser being also 1 mm. apart. These ten condensers are arranged side by side in a line and the pencil of rays passes between each pair of plates in turn and finally strikes a thermopile, which thus measures the kinetic energy of the aggregate of particles falling upon it; and when the condensers are short-circuited, this energy is the sum of those of the charged and of the uncharged particles. When, however, a potential difference is established between the plates of the condensers, a diminution is observed in the thermopile reading in consequence of the elimination of some of the charged particles, and as the potential difference is increased this reading approaches a constant value which gives the energy of the uncharged particles alone. From these data the ratio of  $L_1$  to  $L_2$  can be calculated.

If now the pencil of canal rays be entirely freed from charged particles by the first condenser, the remaining uncharged particles continue the process of acquiring and losing charges after they have passed away from that condenser, and a fresh determination similar to that just described can be made by charging a further one of the ten condensers, in addition to the first. It is then found that the ratio of  $L_1$  to  $L_2$  for this (initially uncharged) beam depends on the distance between the two charged condensers, and in this way  $L_2$  itself can be found.

In the investigation just described the pencil of positive rays consisted of particles of very mixed velocities and chemical character. Ruchart, however, afterwards employed a tube made in two parts with a universally swivelling joint, and spread the pencil out into parabolic sheets by applying simultaneous electric and magnetic fields. Particles of a particular velocity and chemical character were selected by means of slits, and the selection could be varied by relative movement of the two parts of the tube. The measurements already described were then repeated with the homogeneous pencils obtained. If the reciprocal of  $L_2$  as thus found be plotted against the pressure in the tube, the resulting graph is a straight line the gradient of which depends on the velocity, as would be expected, but it does not pass through the origin. The latter discrepancy has been explained by Ruchart as due to residual gases emitted from the metal parts of the tube and from the cement, and can be reduced by reducing the size of these elements. As the velocity of the particles is increased by in-

creasing the accelerating potential,  $L_2$  becomes smaller while  $L_1$  becomes larger, the ratio  $L_1/L_2$  ranging from about 0.05 to 0.5. From the mean free path the collisional radius of an atom can be calculated, and this is found to lie between the first and second Bohr orbits in the case of hydrogen. The free paths are given by Ruchart's method with an accuracy of a few per cent.

A further investigation has been made on the subject of the mean free paths by the study of the light emitted. Three kinds of mean free path have to be considered in this connexion. (1) The first is the path for the "duration of luminosity"; this path begins when the atom is excited by the raising of an electron to a higher energy level within the atom, and ends when the electron returns with emission of light. Eighteen years ago Prof. Wien compared the luminosity of a black body at a temperature of about 1100° C. with that of the canal rays, in a vacuum so high (0.001 mm. for hydrogen) that the effect of collisions could be neglected. The energy emitted by the canal rays as light was thus determined in absolute measure, and from this it was possible to calculate the light energy emitted per atom per cm. of an atom's path. The observations were made in a vacuum chamber separated by a very fine slit (through which the canal rays passed) from the tube in which the rays were produced, and were concerned with the strongest lines of hydrogen, oxygen, nitrogen, helium and mercury. It was found that the luminosity fell off exponentially with distance along the path of the rays, and from the exponential constant the mean free path for duration of luminosity can be calculated by introducing quantum considerations. It amounts to a few centimetres. The measurements just mentioned related to the state of things in a very high vacuum, the slit referred to being so fine that the vacuum in the experimental chamber could be kept at much lower pressure than that in the discharge tube.

At higher pressures, however, the effect of collisions comes into play, and it becomes necessary to consider two further kinds of mean free path, namely, (2) the path which begins when an atom becomes normal and ends when it is excited, on collision, by the raising of an electron to a higher energy level; and (3) the path which begins when the atom is excited, as described, and ends not with the emission of light but with ionisation by a further impact. Prof. Wien termed the latter process "perturbation."

This question has recently been investigated by Prof. Wien by the use of a discharge tube separated from the experimental chamber by a slit so fine that a great difference of pressure could be maintained between its two sides by the use of a diffusion pump; with a vacuum in the tube of 0.02 mm., the pressure in the experimental chamber could be raised to 8 mm. or more. The intensity of the line  $H_\alpha$  (displaced by the Doppler effect) was then compared at various pressures, and it was found that for high vacua the intensity was proportional to the pressure, but for pressures above about 0.5 mm. the intensity was constant. At low pressures few perturbations take place, and as the excitations are proportional to the number of collisions, the intensity is proportional to the pressure. At high pressures, however, the mean free path for collision is small compared with that for the "duration of luminosity"; the excited atoms are more frequently prevented by "perturbing" collisions from emitting light, and ultimately the perturbations balance the excitations and the intensity becomes constant.

The apparatus used for measuring the "duration of luminosity" has also been adapted for use in a method

<sup>1</sup> Substance of the tenth Guthrie Lecture delivered before the Physical Society of London on April 25, by Prof. W. Wien

for discriminating between the spectral lines from charged and those from uncharged particles. A small condenser is placed close to the slit so that the canal rays pass between its plates, the vacuum being as high as possible so that the particles may not, after passing through the slit, become charged or uncharged through collisions. The spectrum of the light emitted by the rays is then photographed, first with the condenser short-circuited and then with the condenser charged. (Apparently the slit ordinarily employed in a spectroscope is here dispensed with, the line corresponding to each wave-length being an image of the pencil of rays itself.) Since the charged particles are deflected by the electric field, the lines due to these particles are distorted when the condenser is charged and can thus be distinguished from the lines due to uncharged particles. Photographs were shown in which certain oxygen and hydrogen lines were seen to be undistorted by the influence of the condenser, while others were clearly distorted. The latter belong to the spark spectrum of oxygen, while the former are arc lines. A similar distortion was observable with the band spectrum of nitrogen.

The foregoing considerations throw light on an apparent discrepancy between measurements of the velocity of the rays by electromagnetic methods and by the Doppler effect respectively. The velocities as measured electromagnetically increase in proportion to the square root of the accelerating potential, in accordance with theory, but the velocities as measured by the Doppler effect have been found by several observers to reach a limiting value as the accelerating potential rises beyond a certain stage. Dr. Krefft, however, raised the accelerating potential in a tube filled with hydrogen to 70,000 volts, and in this case he found no limiting value for the Doppler displacement;

the latter indicated a velocity increasing in proportion to the square root of the potential, but its absolute value was less than what would be expected from the velocities measured electromagnetically. The arc lines of oxygen also show an unexpectedly small shift, while the spark lines show a larger shift. The discrepancy referred to may therefore be attributed to the fact that the bulk of the luminosity comes from uncharged atoms while the electromagnetic measurements relate to charged particles, which on the average have greater velocities.

A further investigation has been made by Ran, who arranged a glass cylinder close to the canal rays and with its axis perpendicular thereto. In this way light from both approaching and receding particles is collected by the cylinder and focussed on the slit of a spectroscope. Ran found some evidence for regarding the band spectrum of nitrogen as emanating from positively charged particles.

New results have been obtained by Dopel in the analysis of positive rays by Sir J. J. Thomson's method, negatively charged particles of  $H$ ,  $H_2$ ,  $He$ , and  $Ne$  (or  $?O$ ) having been found. Most positive-ray parabolas show two regions of maximum intensity, and a new explanation is suggested for this phenomenon, namely, that the second maximum is due to particles of considerable mass originating in the discharge chamber but afterwards dissociated. The existence of molecules of  $He_2$  and  $H_2$  would be implied by this theory, but not  $H_3$ , since there is no second maximum in the case of  $H_3$ .

Prof. Wien remarked in conclusion that the work on positive rays affords an excellent example of the results of international co-operation in science, which he regards as of the utmost value and importance.

C. W. H.

### International Commission for the Investigation of the Upper Air.

A MEETING of the International Commission for the Investigation of the Upper Air was held in London on April 17-22.

At the meeting of the Commission in Bergen in July 1921, the Commission adopted the view that the international publication of the results of the investigation of the upper air ought to be resumed, and that an International Bureau should be established and supported by contributions from the different States, so that the preparation and compilation of the results should not in future be done at the sole cost of the National Service which undertook the work. Unfortunately, it did not prove practicable, in the stringent economic times which followed the meeting of 1921, to obtain the funds which were necessary to carry out the recommendations of the meeting at Bergen. In consequence of this, Prof. V. Bjerknes, who had been president of the Commission, resigned his position, as he could not spare the time from his purely scientific work to carry out unaided the large amount of work involved in the preparation and publication of the international upper air results. Sir Napier Shaw, then President of the International Meteorological Committee, took over the presidency of the Commission at the request of the members.

Various methods for securing the object of an international publication of upper air results have been considered or tried experimentally since that time. No satisfactory solution of the question has been achieved. A short meeting of the Commission was held after the International Conference at Utrecht in 1923 at which the results of the inquiries were briefly surveyed, and a preliminary discussion took place on the most appropriate form for an international publication.

In 1924, at the meeting of the International Union

for Geodesy and Geophysics at Madrid, the Union voted the sum of 500*l.* towards the expenses of publication of a specimen volume of upper air data, and Prof. van Everdingen, the director of the Meteorological Institute of Holland, promised a contribution of about 100*l.* for the same purpose.

The meeting of the Commission in London was concerned primarily with the consideration of the form which the specimen publication should take. Representatives from the following countries attended: France (Capt. Wehrlé); Germany (Prof. Hergesell); Great Britain (Sir Napier Shaw, Sir Gilbert Walker, Capt. C. J. P. Cave, Lieut.-Col. E. Gold, Mr. L. H. G. Dines, Mr. L. F. Richardson); Holland (Prof. van Everdingen, Prof. van Bemmelen); Italy (Lt.-Col. Matteuzzi, Prof. Gamba); Norway (Dr. Hesselberg); Russia (Dr. Molchanoff); Spain (Col. Meseguer). The meetings of the Commission were divided into business meetings and scientific meetings, on the ground that a rightsolution of the questions which the Commission had to consider could only be achieved by a correct appreciation of the scientific principles involved. There were four business meetings and three scientific meetings.

At the first meeting of the Commission on Friday, April 17, the president read a letter from Mr. la Cour, director of the Danish Meteorological Service, giving the Commission the welcome news that four wireless stations would be in operation in Greenland during the coming summer, at Angmagsalik, Julianehaab, Godthaab, and Godhavn; and that all four stations would be equipped with instruments for observations of pilot balloons. The work of the four stations as regards investigation of upper wind would be co-ordinated by wireless with the view of obtaining simultaneous ascents to great heights from all stations at the same time.

In a communication from M. Fontseré (Barcelona) an account was given of some observations on oscillations of short period, indicated by the well-known oscillations of the motion of pilot balloons, as seen in a pilot balloon theodolite. These oscillations appear to have a period of about three seconds, and do not appear to be due to natural oscillations of the balloon. The Commission decided to recommend that a similar investigation should be undertaken in other places, and that the influence of the size and form of the balloon on the character of the oscillations should be explored, and that a comparison of the oscillations observed in balloons with those observed in the tension of kite wires should also be made.

After some discussion of the use that should be made of the funds placed at the disposal of the president, the Commission decided that they should be applied to the publication of a specimen volume of upper air results for 1923 and 1924, and that in the specimen volume the observations obtained from *ballon-sonde* and similar records from the places selected for international investigation, should be published in the form of tables giving full details, and that the tables should be supplemented by graphical representation on "téphigrams." This is the name given to the representation of the results of the *ballon-sonde* ascents, by plotting corresponding values of temperature  $t$ , and entropy  $\phi$ , which is proportional to the logarithm of potential temperature  $\bar{T}$ . This form of representation, which was invented by the president and explained by him at the scientific meeting, is peculiarly appropriate for presenting the results of temperature (and humidity) observations in the upper air. It shows immediately the relation of the temperature gradient observed in the ascent to the adiabatic gradient for dry air and the adiabatic gradient for saturated air. It shows the energy which would be required to raise air vertically in the atmosphere under the conditions of the ascent, or alternatively, the energy that would be set free in a kilogram of air rising in the atmosphere under the conditions of the ascent. It also has the great advantage of presenting these results in a diagram of very moderate dimensions, even when observations at heights of 50,000 feet or more are included.

Considerable discussion took place on a proposal sent by Dr. Marvin for concentrating all the international *ballon-sonde* ascents in any one year into a single month. The proposal to obtain ascents daily for a month in addition to ascents on single days in other months of the year, was advocated by Lieut.-Col. Gold at the meeting at Bergen in 1921, but it was rejected by the Commission on the ground that the funds available for upper air investigation should be devoted to obtaining results for detailed investigation on the lines adopted by the Norwegian Geophysical Institute. After much discussion of Dr. Marvin's proposal, it was agreed that countries participating in the international investigation of the upper air should be asked to make, so far as possible, daily ascents distributed throughout a month in each year, the month to be selected by the International Commission, these ascents to be additional to those indicated in the scheme of international days prepared by the Commission at Bergen for the years up to 1928. The first month selected for this more extended investigation is May 1926, and the next month is October 1927. (It was considered that the time was too short to warrant an "International Month" in 1925, but it was agreed that any auxiliary *ballon-sonde* results which any country might be able to make, should be made in August.)

In the course of discussion of this resolution, Prof. Hergesell emphasised that the international investiga-

tion of the upper air has two aspects, the world aspect and the regional aspect. From the world aspect, ascents over a month would be appropriate, and from the regional aspect, ascents concentrated into shorter periods of time, and made more frequently, would lead to better results. Dr. Simpson, following up this line of thought, made the suggestion that the Commission itself should deal only with the world aspect and should appoint regional sub-commissions to deal with regional aspects. The Commission eventually decided that the regional aspect could, in the meantime, be dealt with satisfactorily by the nomination of deputy-presidents in the following different regions: Europe, with Russia, Siberia, and North Africa; North America; the East Indies and the Philippines, Australia; South Africa; South America. It was agreed that the six ascents left at the disposal of the president should be concentrated in the international months, and the exact dates in the different regions should be left to the deputy-presidents for these regions. Dr. Marvin was designated as deputy-president for North America and Mr. J. H. Field for the East Indies.

The question of adopting an international formula for the rate of ascent,  $\frac{dh}{dt}$ , put forward by Dr. Weinberg (Leningrad), led to the appointment of a sub-commission to consider this and other questions relating to balloons, and to report to the next meeting of the Commission. The members of the sub-commission are: Prof. Hergesell (president), Dr. Hesselberg, Mr. J. S. Dines, Dr. Molchanoff, Col. Matteuzzi, Dr. Marvin, and Mr. Fujiwhara.

The importance of aeroplane observations, and the difficulty of securing satisfactory instruments for them, was emphasised by Capt. Wehrle, and the Commission decided to ask for complete particulars of the instruments and methods used in different countries to be communicated, with the view of their publication in collected form by the French Meteorological Service.

As regards the future, it was decided that the question of a regular international publication could only be settled satisfactorily after the specimen volume had been issued and considered. The question of the publication of results after 1924 was, therefore, remitted to the next meeting of the Commission, which it is anticipated will be held at Prague in 1927.

On Thursday evening, April 16, the delegates were entertained by the president at an informal "At home" at his house. Various graphical methods of presentation and illustration of upper air results were exhibited, and some interesting photographs were shown illustrating the growth and decay of vortices in a fluid in connexion with the theory which Mr. Fujiwhara has developed of the vortex motion exhibited in clouds. On Friday, April 17, the delegates were entertained to dinner by the Meteorological Office. On Sunday, April 19, they were invited by Capt. C. J. P. Cave to lunch at the Beacon Hotel at Hindhead, and afterwards to tea at Stoner Hill, Petersfield, where they had an opportunity of seeing an unrivalled collection of cloud photographs, while the rain outside witnessed to the accuracy of the Meteorological Office forecasts. On Tuesday afternoon, April 21, they paid a visit to Kew Observatory in connexion with the seventy-fifth anniversary of the Royal Meteorological Society, and on Wednesday evening they were entertained at the anniversary dinner of the Society.

The outstanding impression left by the meeting may be illustrated by a remark to me of one of the foreign delegates: "What I like about this international work is the way everybody is ready to help things forward; the only consideration being, 'Is the thing good?' It is very pleasant." E. GOLD.

### Historic Scientific Instruments in the Old Ashmolean Museum, Oxford.

ON Tuesday, May 5, the Old Ashmolean Museum at Oxford was reopened as a home for old scientific instruments, especially the magnificent collection presented to the University by Mr. Lewis Evans, on whom the honorary degree of D. Litt. was first fittingly conferred. After this, a large and brilliant gathering assembled in the Divinity School under the chairmanship of the Vice-Chancellor to hear an account of the collection from Mr. R. W. T. Gunther, fellow of Magdalen, who has been appointed curator; and an address from the Earl of Crawford and Balcarres, president of the Society of Antiquaries, who performed the opening ceremony.

The Old Ashmolean Building, which embodies many of the features of Wren's design for a College of Science, was originally opened on May 21, 1683, by the Duke of York, afterwards James II.; and it was pleasant to have at this second opening, nearly 250 years later, a cordial message from the present Duke of York, transmitted through a specially appointed representative, the president of Magdalen. Lord Crawford, in some inspiring words, welcomed the dispelling of the mischievous fallacy that there is a necessary antagonism between science and art, for in the present exhibition the two are perfectly combined. Instruments that have become practically obsolete survive as beautiful works of art.

The company had ample opportunity to verify this statement; for many of the exhibits have indeed great beauty of workmanship. A little crucifix, the arms and sides of which constitute a vertical sundial, while the interior is filled with drawing instruments, came in for special admiration. Its instruments were spread out beside it, and their number almost suggested that it might be difficult to get back the "game into the bottle." Dr. Evans has told us that his collection began (when he was only eleven!) with sundials; and thought expanded later to include astrolabes and other instruments of precision, it took him twenty years to find his first astrolabe. He was really trying all that time to get one, and prepared to spend money on it, but there were none to be had. In view of the number he has now accumulated, this is very surprising. An interesting development of his collecting tastes is represented by a very fine set of gunnery levels, specially admired by another collector of these treasures.

Besides the Lewis Evans collection itself, there are

many other loans and gifts, attracted partly by the new and splendid opportunities for presentation, and partly no doubt by Mr. Gunther's persuasiveness. Miss Willmott has lent a remarkable astronomical clock, with an astrolabe as dial, two hands to show the positions of the sun and moon, and a mean time clock at the back—all beautifully ornamented. Christ Church and Oriel have both lent important collections—the former a collection of orreries. Doubtless other gifts and loans will come. Mr. Gunther was specially gratified to receive a note from Mr. E. B. Knobel after his visit. "I see from your catalogue you want a Davis's Backstaff: I'll send you one." There are copies of two Galilean telescopes and a Hooke microscope which come from special funds. Perhaps the best example of the advantages brought by the new opportunities is the conjunction of (a) the first circular slide rule (1632), invented by Oughtred, (b) portraits of Oughtred and of Elias Allen, the maker, (c) two books on the subject by Oughtred and Allen. Now (a) is a loan from St. John's College, (b) from the Hope collection of portraits in Oxford, while (c) are from the Evans collection. Thus we see the value of Oxford as a collecting and combining medium, but again, we must not undervalue the knowledge which Mr. Gunther had gradually acquired of the (formerly) hidden resources of Oxford.

We may regard Tuesday's ceremony as the very satisfactory ending of a period of doubt and difficulty with regard to the Lewis Evans collection. The joys of collecting are great; but there comes a time when some anxiety as to the ultimate fate of the collection must temper those joys. Such anxieties must now have been dissipated; and for this happy result we have in great measure to thank the Vice-Chancellor, without whose sympathy and liberal views of the functions of a University even Mr. Gunther's energy might have failed to clear the path from difficulties.

Two points of detail may be mentioned. The little catalogue of the instruments is on sale in the Old Ashmolean Building, *not* in the Ashmolean Museum as (erroneously) printed on the cover. The danger of this confusion is well-nigh unavoidable. Secondly, those interested will find some really excellent pictures of building and exhibits in *Country Life* for May 9.

H. H. T.

### Growth Stages of a Crustacean.

EVERY student of zoology has some acquaintance with the larval stages of those Crustacea that undergo metamorphosis, but there has hitherto been no detailed account of the changes during growth in any of the species in which development is direct. In the course of researches on the genetics of *Gammarus chevreuxi* carried out at Plymouth, Mrs. E. W. Sexton found it necessary to have fuller information as to the characters of the successive stages from hatching to maturity. She therefore set herself to the laborious task of studying and depicting, with her well-known artistic skill, complete series of the moulted skins of isolated individuals. The results are now recorded in a paper (Journ. Marine Biol. Ass., vol. 13, No. 2, pp. 340-396, 21 pls., 1924) which is of unusual interest and importance from several points of view.

Apart from certain changes in the proportions of the body, the differences between the various stages are slight and concern mainly the form, number and position of the hairs and spines on the body and limbs. These trivial differences, however, are remarkably

constant, and by means of them the successive stages can be as sharply defined and as surely recognised as can the larval stages of those Crustacea in which the changes of form are more striking. It is especially noteworthy that this constancy is undisturbed even by considerable changes in the environment. *Gammarus chevreuxi* will live and breed equally well in fresh, brackish or sea-water; it breeds all the year round, and the winter broods take more than twice as long to reach maturity as do those hatched in the summer, yet "the stages of growth were found to be identical, even to the number and position of the hairs." As these statements are based on the study of more than 3000 moults obtained during a period of twelve years, we may confidently take Mrs. Sexton's word for it.

Sexual maturity is reached by both sexes after the seventh moult. The females continue to grow and to moult without further change of form. The males, however, do not attain their definitive characters until the ninth moult. There are, therefore, three

forms of breeding male which might well be taken to belong to different species. It is suggested that this fact, hitherto unknown, may have caused much confusion in the taxonomy of these Amphipoda.

The occurrence of "intersexes" in this species has already been recorded in earlier papers by Mrs. Sexton. These were "female intersexes," and the study of their life-history now shows that they begin as females and develop more and more of the male characters as they grow. "Male intersexes" are also mentioned, but these might be better described, perhaps, as incomplete males, since their effeminate appearance is due rather to the persistence of immature characters than to the assumption of those that are peculiarly female.

Brief accounts are given of the life-history of three other species of Gammarus found at Plymouth. Although the structural characters which distinguish them might be thought trivial by any one but a specialist, the differences in their breeding habits are very marked and "probably form an insuperable bar to cross-breeding" even when the species occur together.

A small detail of interest to the morphologist was observed in the antennules. On the upper surface of the first segment is a narrow longitudinal groove planted with a row of plumose sensory hairs. This is, no doubt, a vestige of the so-called "auditory sac" or statocyst, found in many decapods and also in the Syncarida but not hitherto recognised in any other Crustacea.

In passing, Mrs. Sexton deals with "a picturesque legend" which has been widely quoted from Spence Bate, who gives it on the authority of Dr. James Salter. It is to the effect that the young gammarids, on quitting the brood-pouch of the mother, keep close to her as she swims about and, on the approach of danger, rush back to the pouch for shelter. Spence Bate not only expends some rhetoric on this "interesting instance of maternal solicitude," but also gives us a pretty picture of the mother Gammarus accompanied by her brood. Mrs. Sexton tells us that there is not a word of truth in the whole story. The young could not possibly re-enter the pouch if they tried, and in *G. locusta*, the species to which Spence Bate refers, hatching is followed immediately by emergence of the young, moulting of the mother and deposition of a fresh batch of eggs. W. T. C.

### University and Educational Intelligence.

CAMBRIDGE.—The Museum of Archaeology and Ethnology has received from the Earl of Denbigh the Pennant Collection consisting of a very important series of ethnological objects collected by Captain Cook himself in the Pacific, a series of archaeological specimens which is of great interest and value.

Dr. Scott, Trinity College, has been reappointed curator in entomology; Mr. P. M. S. Blackett, King's College, has been appointed assistant demonstrator of experimental physics; J. Barker, Trinity College, has been reappointed to the Frank Smart studentship in botany; A. B. Deacon, Trinity College, has been elected to the Anthony Wilkin studentship in ethnology and archaeology; G. E. Hutchinson, Emmanuel College, has been nominated to use the University table at the Zoological station at Naples.

Prof. Niels Bohr is lecturing on "Problems of the Quantum Theory" at the Cavendish laboratory, on Friday, May 15.

The annual report of the Board of Research Studies provides interesting reading. The number continues to rise and there are now 248 students registered and working under the administration of the Board. The chief increase in any subject is in physics, where there are now 40 research students. The number of

Cambridge graduates who have registered as research students continues to increase and has now reached 80. The number of American students shows a marked increase. The distribution in colleges still remains very unequal, the numbers ranging from 46 at Trinity College, 38 at Emmanuel College, and 34 at Gonville and Caius College to 2 at Pembroke College, 1 at Jesus College, and 0 at Selwyn College.

LONDON.—A free public lecture (in English) on "Modern Conceptions of Light Stimuli in Plants" will be given by Prof. F. A. F. C. Went, of the University of Utrecht, at the Imperial College, Royal School of Mines, on Monday, May 25, at 5.15. No tickets will be required.

The University Studentship in Physiology, value 50*l.*, will be awarded to a student qualified to undertake research in physiology. Applications should reach the Academic Registrar by, at latest, June 1.

Applications are invited for grants from the Thomas Smythe Hughes Medical Research Fund for assisting medical research. They should be sent, accompanied by the names and addresses of two references, to the Academic Registrar, University of London, South Kensington, S.W. 7, not later than June 15.

MANCHESTER.—In connexion with the Municipal College of Technology the Edmund Mills Harwood Memorial Scholarship, value 50*l.* a year, and tenable for three years in one of the University engineering courses, is offered for competition. Forms of nomination and further information are obtainable until June 15 from the Registrar of the College.

PROF. B. HELFERICH, of Frankfort-on-Main, has been invited to occupy the chair of chemistry at Greifswald in succession to Prof. R. Pummerer, who has been transferred to Erlangen.

THE Society for the Advancement of the Training of Mechanics, Leyden, has arranged for the holding in August of vacation courses for mechanics and glass-blowers in the workshops of the Physical (Cryogenic) Laboratory of the University of Leyden. Information respecting the courses can be had from the Secretary, Dr. C. A. Crommelin, at the laboratory.

THE University of Birmingham has evolved a system of research economy which deserves to be commended to the notice of other institutions. Four years ago, the University established a Joint Standing Committee for Research with the object of making a general policy and recording from session to session as completely as possible all the research work conducted by members of the University staff. The committee's main work is now to grant financial assistance from its own resources, to support, at its discretion, applications by heads of departments to outside bodies, to keep in close touch with all work properly described as research work going on in University Departments or in Departments working under the University, and to record and publish work completed and in progress. With the third annual report (1923-24) particulars were published of 170 researches in progress in the faculties of science, art, medicine, and commerce, and of 150 publications embodying completed researches, and, in addition, accounts of archaeological excavations and of work carried out under the City and University Joint Board of Research for Mental Disease. The resources of universities are so diverse that a common policy in regard to the promotion and organisation of research may not be called for, but in regard to systems of recording and classifying particulars of research, the advantages of uniformity are very

evident, and ought to be attainable without much difficulty.

In his presidential address on "University Ideals" to the Yorkshire Natural Science Association in Bradford, which has recently been issued, Prof. A. F. Barker of Leeds discusses the ideals characteristic of the schools of the humanities, of pure science, and of applied science, and the relation to them of the scientific and technological bias, which is the most distinguishing feature of the modern universities. He adopts the view of Dr. L. P. Jacks, that so long as civilisation remains predominantly industrial, all attempts to find culture, religion, salvation outside the sphere of our daily work must "resolve themselves ultimately into spoken nothings." To render the training of the faculties fruitful, they must be made sensitive to the appeal of natural science. The student must be taught to regard Nature, natural science, technology, and the objective world generally as a mirror in which man may see himself. "The limitation of our powers of vision is in ourselves; and the University's highest and deepest concern lies in the stimulation, through contact with the subjective and objective worlds and with the everyday life of the world which lies about us, of the light within ourselves—of our evolving consciousness." This is to apply in the university the principles of what is known in American pedagogical terminology as the "project method." The same principles are advocated in a pamphlet by Prof. J. W. Scott of University College, Cardiff, under the name of "the regional idea," for revitalising the teaching in our elementary schools to the end that their pupils may be better equipped for life in the world of industry ("Unemployment—a suggested remedy," A. and C. Black, 1925, 1s. net). In connexion with the encouragement of individuality in organisation, which seems to Prof. Barker an essential feature of the modern university system, he refers to "the fight for the inclusion of the Research Associations within the university," and "the fight which is now being waged in several of the modern universities in England for the reintroduction of religion into the university life in some form or other."

THE morning session of the annual Conference of the Universities of Great Britain and Ireland, held at King's College, London, on May 9, was devoted to a discussion on "The Function of the Universities in Relation to Agriculture." Sir Daniel Hall, chief scientific adviser to the Ministry of Agriculture, was the principal speaker. He is of opinion that agriculture students and courses fall into three groups: at certain universities, notably Oxford and Cambridge, many of the future landowners of the country form a considerable proportion of the students. For them a degree course in agriculture is required which will awaken in them a sense of their responsibilities and opportunities. Then there are the men who actually intend to farm; they require a technical training, which might be more conveniently given at a university than at a separate agricultural college, where they would miss that opportunity of widening their knowledge which contact with students of different subjects in a university affords. Finally there are teachers, scientific workers and officials, whose training should be based on a degree course in arts or in pure science. Sir Daniel thinks that there are sufficient agricultural colleges already in Britain and that each should pick out its special group and cater for its needs. In the discussion which followed, Mr. M. J. R. Dunstan, principal of the Royal Agricultural College, Cirencester, suggested a round-table conference of university authorities in Great Britain to decide the scope and training for an agricultural degree.

### Early Science at Oxford.

May 18, 1686. Some of this Society having considered that place of Tacquet's Geometry, mentioned in the Minutes of the Dublin Society of March ye 8th. observed that there is this difference betwixt Mr. Caswell's first Problem and Tacquet's, viz. that in each of Tacquet's Triangles there is one side and 2 Angles given, which is an ordinary case of Trigonometry: But none of Mr. Caswell's Triangles has one side and 2 angles, or 2 sides and one angle, or 3 sides given, and this makes a greater difference in the Solutions than that mentioned, in those minutes.

Then was read an account of the Torricellian experiment, tried on the Mountaines of Snowdon, Cader Idris, &c. with the heights of those mountains taken by Mr. Caswell.

An account was given of *four children* born at a birth, at Marston near Oxford, the last Mounth.

May 19, 1685. A Letter from Dr. Mark, Physitian to the Elector of Brandenburg, and Member of this Society, dated Potsdam, March 28, 1685, was read; It brought an account how well his Electorall Highnesse is pleased with ye design of this Society. His Highnesse having commanded Dr. Mark to continue a strict correspondence with us, and promising him assistance, by furnishing him with matter to communicate, when his own stock shall be defective. The Elector also commanded him to enquire concerning ye Concha, which affords ye Purple, and of ye way of making Amianthus-paper, and to procure both, if possible. He has also given orders for some of ye Philosophical Transactions to be sent over. The Society ordered their humble thanks to be returned to Dr. Mark for this welcome newes; for the Honour done them in it; and for (the occasion of it) ye character he has been pleased to give of this Society to the Elector; and that answers be speedily sent to ye queries in ye Letter; and that ye Letter itself be carefully preserved among ye papers of this Society.

Proceeding then to other matters, two specimens of bookes, now in the presse, were shewn us; one a History of Fishes, written, some years since, by Mr. Willoughby, and Mr. Ray: the other, a History of Plants, by Mr. Ray, after his new method.

A Sort of Earth, dug at Hogsdon, 8 or 10 foot deep, of an Aromaticall smell, was communicated by Dr. Plot; who inform'd us, that the Water under this Earth is found Bituminous, from whence, he conjectures, ye Earth may be supposed to have this flavour.

May 20, 1687. Mr. President was pleas'd to communicate a letter from Mr. Halley, which gives an account of Mr. Newton's Book *de Systemate Mundi* now in ye presse, giving an account of ye reasons of ye Celestial motions &c.; and of Mr Hooke finding ye meridian line with great exactnesse by the help of a Small constellation near ye Pole.—Mr President also communicated a Letter written by him in answer to Mr. Hally's, giving an account of ye reasons, why he can not be of Mr. Hooke his opinion, concerning the figure of ye earth.

May 22, 1688. Mr. Molyneux sent an account of the Inhabitants of the Barony of Forth in the County of Wexford, who are the Progeny of the first English Planters that came over with Fitzstephen and conquered Ireland in Henry 2ds Time. Till the times of their late confusions in Ireland (he says) they retan'd in great Measure their Antient Language, neither good English nor Irish, but easier understood by a perfect Englis man then Irish. That till of late they allways kept their Marriages intire amongst themselves.

## Societies and Academies.

LONDON.

**Royal Society, May 7.**—W. Rosenhain and Miss J. McMin: The plastic deformation of iron and the formation of Neumann lines. Experiments have been made to ascertain the effect of variations of speed on the mode of deformation of nearly pure iron. Small rectangular prisms, having one face prepared for microscopic examination, have been compressed slowly in a testing machine and also under the blow of a falling weight. Within the range of speeds possible on the testing machine used (from 20 minutes to approximately 1 second) slip bands of very similar character are formed. When, however, such a specimen has been compressed by the blow of a falling weight very few slip bands are formed, but the crystals are crossed by much heavier and usually very straight black bands, which have been identified with the well-known Neumann lines. The formation of Neumann lines is probably not due to twinning; they are rather of the nature of broad slip regions, possibly formed by the close juxtaposition of a large number of slip planes. The surfaces on which slip has recently occurred are regions of weakness for further deformation by shock, although they do not appear to behave in the same way with further gradual deformation.

—A. E. H. Tutton: (1) The monoclinic double sulphates containing thallium.—Thallium nickel and thallium cobalt sulphates. The two salts are  $\text{Ti}_2\text{Ni}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$  and  $\text{Ti}_2\text{Co}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ . They show close isomorphism with salts of the series containing the alkali metals, but not "eutropism" (progression with atomic number). Thallium in its thallous capacity is thus capable of replacing the alkali metals in the crystals of these double salts, with only a relatively small amount of change like that produced by alkali metal interchange, but without relationship to atomic number. The two new thallium salts, in common with those previously studied and also with the simple rhombic sulphate and selenate of thallium, are distinguished by their very high (relatively to other salts of the two series) refraction and dispersion. This is probably where the more complicated nature of thallium atoms produces its effect. (2) The crystallographic and optical properties of iodo-succinimide. Miss Yardley's X-ray results indicated a structure corresponding with the symmetry of Class 9, the pyramidal polar class of the tetragonal system, one of the classes in which optical activity in two optical antipodes is possible. It has hitherto been assumed that iodo-succinimide is ditetragonal pyramidal (Class 13). New morphological constants were found and optical activity has been discovered, blocks about 4 mm. thick being required to exhibit it clearly. Hence, Miss Yardley's conclusion that the symmetry is that of Class 9 is in every way confirmed.

—Kathleen Yardley: An X-ray examination of iodo-succinimide. The dimensions of the true unit cell are  $6.29 \times 6.29 \times 15.55$  Å U. This minimum cell contains four molecules. The X-ray measurements predict that the crystals should be optically active; Dr. Tutton has since shown that this is actually the case.

—B. Lambert and S. F. Gates: An investigation of the relationships existing between hydrogen and palladium. The "ascending" pressure-concentration isothermal drawn through equilibrium points obtained after successive additions of hydrogen to palladium is not, in any sense, an equilibrium curve. The "descending" pressure-concentration isothermals, drawn through equilibrium points obtained after successive withdrawals of hydrogen from the

system, are regular, but interruption of the smooth withdrawals of gas by occasional additions of gas, and temporary cooling, have marked effects; the "descending" isothermal cannot, then, be considered an equilibrium curve. The existence, under some conditions, of a simple compound,  $\text{Pd}_2\text{H}$ , is considered not improbable.

—C. G. T. Morison: The effect of light on the settling of suspensions. Fine-grade suspensions of soil and kaolin were used in the absence and presence of light. When a suspension settles in the absence of light the settling is uniform and normal. In the presence of light it develops well-marked striations and discontinuities.

—Colonel N. T. Belaiev: On the inner crystalline structure of ferrite and cementite in pearlite. Pearlite, the "pearly compound" of Sorby, is built up of grains of alternating lamellæ of cementite and ferrite. The orientation of these lamellæ is different in different grains. The cementite lamella shows its "petal-like" structure and seems warped and twisted. The exposed outer edge shows rectangular steps pointing to a constant linear unit. The ferrite lamella reveals, at the edge, "isolated cubes" of ferrite of about  $250 \mu\mu$  edge. The ferrite lamella seems to be built up of a multitude of such small cubes, and both the warping of the cementite lamellæ and the cracking of ferrite may be traced to the  $A_1$  point, where the expansion of volume, due to the change from the face-centred to the cube-centred lattice in iron, counteracts—in the pearlite areas—the normal contraction of the cooling specimen. Reacting to the ensuing stresses, the cementite lamella becomes warped and twisted, and the ferrite splits up into a multitude of blocks or cubes.

**Royal Microscopical Society, March 18.**—C. Da Fano: (1) On the mounting in series of specimens stained by the Weigert-Pal method. Well-bichromated material is embedded in celloidin. The blocks are cut serially and the sections placed in order on slips of smooth paper. After drying with filter paper a progressive number is written with a mixture of 10 c.c. of indian ink and 3 c.c. of equal parts of ether and acetone on a corner of the celloidin by means of a brush. The sections are floated in weak alcohol, washed, and mordanted in a mixture of potassium bichromate 5 gm., chromium fluoride 2.5 gm., distilled water 100 c.c. They are then stained in Kultschitzky's hæmatoxylin, differentiated by Pal's method, counterstained and mounted according to the progression of their numbers. (2) Golgi-Cox preparations mounted permanently in series. Relatively large pieces of nerve tissue or even entire brains from small animals are placed in Cox's mixture. The fluid should be changed after 24 hours and again on the third day. The pots containing the material are sealed and kept for a month at  $24^\circ \text{C}$ . and then for about 6 months at room temperature. The pieces are washed, dehydrated, embedded in celloidin, and serial sections made.

—A. S. Parkes: The age of attainment of sexual maturity in the albino mouse. The examination of the gonads of young mice showed that mature spermatozoa are produced by the male at a much earlier age than ova are produced by the female. In the case of the male, active spermatozoa first appear in the epididymis during the sixth week of life. Testis sections corroborated this finding. In the case of the female the first ovulation occurs about the eighth week, though the condition of the animal obviously has a considerable influence in determining the time of the first production of both ova and spermatozoa. The vaginal orifice first opens towards the end of the seventh week, at which time also the uterus develops to a condition approaching maturity.

**Royal Meteorological Society, March 18.**—C. K. M. Douglas: The relation between the source of the air and the upper air temperature up to the base of the stratosphere. Trajectories of "gradient" wind were drawn, showing the previous history of the air in which *ballon sonde* ascents were made, in cases where the place of fall of the balloon showed no great change of wind with height. These showed that the latitude of the air three days previously is highly correlated with the temperature at all heights to the base of the stratosphere, with the height of the stratosphere, and with the pressure at 9 km. The latitude effect, which in general represents the temperature difference between "polar" and "equatorial" air, increases somewhat with height, up to at least 6 kilometres.—A. H. R. Goldie: Waves at an approximately horizontal surface of discontinuity in the atmosphere. Autographic instruments with open time scales show examples of fluctuations of atmospheric pressure which are undoubtedly periodic. By way of determining the origin of these, the general problem of wave-motion at the common boundary between two air currents differing in density and in velocity and direction of motion is discussed. The theory can account plausibly for the observed facts; waves with amplitudes in the bounding surface of from 150 to 750 metres or perhaps more, and with lengths of the order of from 5 to 20 kilometres, must be of comparatively frequent occurrence.—Sir Napier Shaw and H. Fahmy: The energy of saturated air in a natural environment.

## DUBLIN.

**Royal Dublin Society, March 31.**—H. Pringle: The identity of vitamin A: the comparative effects of human and cow's milk. Cow's milk is much more efficacious than human milk in promoting growth in rats.—J. Wilson: The variations in the quantities of food required by cattle for maintenance and fat production with various kinds of rations. From Kellner's own experiments, the quantity of food required by cattle for idle maintenance is not constant, as Kellner found, but varies with the kind and quantity of long fodder in the ration. With 11 to 12 cwt bullocks, it is equivalent to about 13, 15, and 16.5 lb. of hay, when the ration contains less than 0.6 lb. of hay, about 1 lb. of hay, and about 1 lb. of hay and straw respectively per live hundredweight of the animal. When the bullock is fattening, the quantity of food required to put on fat varies with the kind and quantity of long fodder in the ration and with the rate of fat production. If all not retained by the animal be regarded as maintenance, the bullock, like the pig, puts on a pound of fat with a little more than 2 lb. of meals.

## PARIS.

**Academy of Sciences, April 6.**—The president announced the death of M. Rabut, member of the Academy.—H. Vincent: New researches on the pathogeny of colibacilluria. The action of an anti-colibacillus therapeutic serum.—L. Vegard, H. Kamerlingh Onnes, and W. H. Keesom: The emission of light by solidified gases at the temperature of liquid helium, and the origin of the auroral spectrum.—P. J. Myrberg: Arithmetical invariants.—H. Eyraud: Two complementary deformations of space.—Léon Pomey: The integration of differential equations with general initial conditions comprising those of Cauchy.—Mlle. O. Jasse: Observations of the Schain (1925 *a*) and Reid (1925 *b*) comets made at the Marseilles Observatory (Ecliptic equatorial, 26 cm. aperture). Positions given on March 29 and 30. Schain's comet forms a nebulosity 2' in extent, with a nucleus of 11.5 magnitude. Reid's comet, 9.5

magnitude, shows a strong condensation surrounded by a nebulosity 3' in extent.—P. Chofardet: Observations of the Schain (1925 *a*) and Reid (1925 *b*) comets made at the Besançon Observatory with the *coudé* equatorial. On March 30 Schain's comet was of the 11th magnitude, 40" diameter, with a nearly central nucleus: Reid's comet on March 31 was of the 8th magnitude, with nucleus 8" diameter, tail faintly outlined.—Emile Belot: The trajectory of the proto-sun in the primitive nebula: the origin of comets.—Jean Villey and Pierre Vernotte: The electrical maintenance of pendulum oscillations without physical contact. The oscillations can be maintained by the electrostatic attractions between the pendulum and its fixed supports. An outline of the necessary conditions is given.—A. Grumbach: The surface phenomena in photo-voltaic elements with a fluorescent liquid. The effect of the illumination on the electromotive force of the cell platinum—fluorescent solution—platinum has been studied. The variation of potential caused by the illumination is a function of the lighting, and of the nature and concentration of the solution, but is independent of the initial electrical conditions.—Charles Chéneveau: Some optical properties of turbid solid resinous media. Opaque resins, natural or artificial, which may be regarded as the inverse of suspensions of resins in water, obey the general optical laws of turbid media containing large particles.—G. Réchou: The spectrographic study of the *K* series of the heavy elements. Values are given for the  $\alpha_2$ ,  $\alpha_1$ ,  $\beta$ , and  $\gamma$  lines for ten elements (tantalum to uranium).—P. Job: The spectrographic study of the iodocadmium complex. The existence of the complex ion  $\text{CdI}_4$  is proved, and the equilibrium constant  $k$  of the reaction  $\text{Cd}^{++} + 4\text{I}^- \rightleftharpoons \text{CdI}_4^{--}$  deduced from the measurements.—A. Mailhe: The catalytic decomposition of the acid chlorides. The vapours of isovaleryl, isobutyryl, propionyl, acetyl, and benzoyl chlorides were passed over nickel at about 420° C. Analyses of the gases produced in each case are given.—I. P. Voitești: Faceted pebbles in the tectonic breccia in the salt massif of Roumania.—J. Savornin: Djebel Hadid (Eastern Grand Atlas).—Frédéric Hermann: The fan of Bagnes and the Dent Blanche layer.—L. Eblé. Magnetic measurements in the centre of France. The magnetic elements are given for 45 stations in the Departments of Loir-et-Cher, Cher, and Nièvre.—R. Bureau and M. Coyecque: Atmospherics on the oceans. Their meteorological characters.—Henry Hubert: Practical problems of meteorology concerning French West Africa.—P. Lavalie. The embryonic sac of the Dipsacæ.—H. Colin and Mlle. Y. Trouard-Riolle: The crossing of smooth-haired black barley with rough-haired white barley (Albert barley).—A. Goris and M. Métin: The preventive action of anethorine towards aconitine. If less than a lethal dose of anethorine is injected into guinea-pigs, followed by a fatal dose of aconitine, the animal is protected by the anethorine, but the latter has no action as an antidote after injection of aconitine. The preventive effect of anethorine persists for at least twenty-four hours.—M. Parat and J. Painlevé: The exact concordance of the characters of the vacuome and the classical apparatus of Golgi.—Edouard Chatton and Mme. Chatton: The action of external factors on the Infusoria. The conjugation of *Glaucoma scintillans* is determined by the modification of the proportion of the constituents of a chemically defined medium.—Paillot: The cytoplasmic and nuclear alterations in the course of the evolution of *grasserie* of the silkworm.—G. Guittonneau: The formation of thio-sulphate at the expense of sulphur by the micro-organisms of the soil





SATURDAY, MAY 23, 1925.

## CONTENTS.

	PAGE
The "Electronic Reactions of Abrams" . . . . .	789
Geodynamic Problems of the Alps. By J. W. G. . . . .	791
Modern Metallurgy. By Prof. H. C. H. Carpenter, F.R.S. . . . .	793
Science and Religion. By Rev. J. C. Hardwick . . . . .	795
Our Bookshelf . . . . .	796
Letters to the Editor :	
Quantum Radiation.—Sir Oliver Lodge, F.R.S. . . . .	798
D. C. Miller's Recent Experiments, and the Relativity Theory.—Dr. Ludwik Silberstein . . . . .	798
Phylogeny as an Independent Science.—Prof. V. Franz ; E. W. M. . . . .	799
The Orientation of Stonehenge.—E. Herbert Stone . . . . .	800
A Stranded Cetacean.—H. C. Chadwick . . . . .	801
Lightning.—Capt. C. J. P. Cave . . . . .	801
Decay and Regeneration of Radio-luminescence.—Charles H. Viol, Glenn D. Kammer, Arthur L. Miller . . . . .	801
Hydra and the Tadpoles.—Prof. Sydney J. Hickson, F.R.S. . . . .	802
Rainfall Correlations in Trinidad.—W. R. Dunlop . . . . .	802
On the Spark Spectrum of Tungsten in a Helium Vacuum Arc.—Prof. Harvey B. Lemon . . . . .	802
The Story of the Mont Blanc Observatories. By Dr. A. E. H. Tutton, F.R.S. . . . .	803
Soaps and the Theory of Colloids. By Prof. J. W. McBain, F.R.S. . . . .	805
The Southampton Meeting of the British Association	808
Obituary :—	
Mr. W. W. Rouse Ball . . . . .	808
Current Topics and Events . . . . .	809
Our Astronomical Column . . . . .	813
Research Items . . . . .	814
Institut International de Chimie Solvay. By H. E. A. . . . .	817
Heavy-Oil Engines . . . . .	818
Tertiary Floras . . . . .	819
The Royal Society Conversazione . . . . .	819
University and Educational Intelligence . . . . .	820
Early Science at Oxford . . . . .	821
Societies and Academies . . . . .	821
Official Publications Received . . . . .	824
Diary of Societies . . . . .	824

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The "Electronic Reactions of Abrams." <sup>1</sup>

A N acrimonious discussion has been carried on for some time past concerning the merits of a method of medical diagnosis and therapeutics generally known as the "Electronic Reactions of Abrams" Dr. Albert Abrams graduated in medicine at Heidelberg at the age of nineteen years. At thirty-seven, after many years' practice in San Francisco, he founded a therapeutic method which he called "Spondylotherapy," and six years later, in 1910, he introduced a method of diagnosis and treatment based upon a new physiological phenomenon which he claimed to have discovered and which he named "electronic vibrations." The rate of these vibrations he held to be constant for each individual, each organ, and each disease. It is measured by an Adams's "Dynamiser" in circuit with the patient or with something more or less miscellaneous belonging to the patient, his blood, sputum, saliva, or even his signature. Readings are taken according to certain changes in the abdominal percussion note of the patient or of a "subject" or "medium" interposed in the circuit with the patient's blood, sputum, or similar substance.

The "dynamiser" is a box containing three electrodes; of these the two lower, on which the specimen rests, are electrically connected to earth, while the third, which forms part of the lid, is connected in series with two (or three) resistance boxes. The first of these is called the "amplifier," while the second (and third if present) is known as a "reflexophone." From the last resistance a wire passes to another electrode held in close juxtaposition with the forehead of a normal healthy person, standing on earthed plates "facing west" and known as the "subject" or "medium." Certain areas on the abdominal wall of this "subject" are then percussed by the operator, and for each such area the first "reflexophone" is adjusted until the normal percussion note changes to "dull"; the readings of the "reflexophone" corresponding to such changes of note are known as the "rates" of "electronic vibration." Abrams's comprehensiveness was not confined to the terminology of wireless telegraphy. Sex, race, religion, as well as disease in all its varying forms and sites, had for him their proper "rates of vibration," of which they were merely the expression. So he reversed his procedure and invented the "oscilloclast," which, by producing any desired rate of "electronic vibration," might be expected to change, if not the sex, race, and religion of his patients, at least their pathological

<sup>1</sup> A Preliminary Communication concerning the "Electronic Reactions" of Abrams, with special reference to the "Emanometer" Technique of Boyd. Read before a Joint Meeting of the Sections of Medicine . . . . . 1. . . . . of the Royal Society of Medicine, January 16, 1925, by Sir Thomas Horder on behalf of M. D. Hart, Dr C. B. Heald, Sir Thomas Horder, Lieut.-Col H. P. T. Lefroy, W. Whately Smith. Pp 56. (London. John Bale, Sons and Danielsson, Ltd., 1925) 2s. 6d. net.

states. "The climax was reached with the assertion that both numbers and letters were possessed of sexual characteristics, odd numbers and vowels being feminine, while even numbers and consonants were masculine."

The "oscilloclast" is leased to practitioners for 150*l.* on condition that it must not be opened; but according to Messrs. A. S. E. Ackermann and W. Clark, consulting engineers, the greater part of the apparatus is functionless, the essential part consisting of a simple rocking magnetic interrupter, which permits about a micro-ampere of current, interrupted about 200 times, to flow to the patient. There seems, however, to be some inconstancy in the contents of the mysterious box.

In the face of ridicule, and unchastened by numerous test results of the most ludicrous description, "E.R.A." has become an established cult. It has taken root in England, where there is now a "small British society of doctors who employ Abrams's methods," the Society of Electronic Medicine. Nevertheless, "employment" of Abrams's methods appears to be an imperfect description, for, composed of "genuine" Abrams workers, but unsuccessful in its application to the leaders of the "cult" in the United States for information concerning the machines its members use, the Society has agreed unanimously to explore the mechanism of the instruments supplied and publish all details (*British Medical Journal*, January 10, 1925). Moreover, it is made clear that the "genuine" Abrams workers, up to January 26, had not wholly embraced the theories of the master, for "our researches (apart from treatment results) have not enabled us to say more than that an as yet undefined relationship exists between 'reactions' and disease" (*British Medical Journal*, January 31, 1925).

When the claims of the Abrams school were first reported in England, they attracted the attention of Dr. C. B. Heald, Medical Adviser to the Director of Civil Aviation. The Director authorised an investigation which resulted inconclusively. In consequence, Dr. Heald, with Lieut.-Col. Lefroy, head of wireless research at the Air Ministry, Mr. M. D. Hart and Mr. Whately Smith, who are engaged on physical research on behalf of the War Office and Air Ministry respectively, carried on the investigation unofficially. Later, Sir Thomas Horder acted as chairman co-ordinating their work.

A preliminary communication concerning the investigation prosecuted from that time onwards has now been published in pamphlet form by Sir Thomas Horder. It is an exceedingly puzzling document. While it is clear that extensive and painstaking investigations have been carried out, the report is argumentative rather than critical, deals only with a modification

of Abrams's box, called the Boyd "Emanometer," reserves important parts of the evidence, and while frankly denying to the electronists any shred of justification, ethical or scientific, for their practice, gives the unfortunate impression that there is "something in it" without elucidating in the slightest degree the nature of the "something" evidenced. Boyd's "emanometer" as described by Sir Thomas Horder substitutes for the variable resistances of Abrams's box "a variable inductance and a variable condenser" in series with a "receiving plate" and a "normal human subject standing on earthed plates facing west." "An outstanding feature of the Boyd apparatus is the incorporation of earthed metallic screens, which are claimed to eliminate contamination from external sources."

The "operator" and "subject" in a series of experiments in Glasgow were "two Gallowgate boys"—i.e. one Gallowgate boy percussed the abdomen of another Gallowgate boy, and his verdict concerning the percussion note constituted the "result." The tests consisted in (1) the discrimination between two apparently identical substances; (2) the identification of one specific substance from among a number of others; and (3) the determination of whether a specimen exhibited was "screened" or not from the receiving plate.

Most of the results were correct, and Sir Thomas Horder, setting aside the possibility of chance, considers "the veridicity of the phenomena in question" to be fully established. But what are the "phenomena in question"? What is it that "does something"?—the emanometer, the "substance," the experimenter, the Gallowgate boys, or some unconsidered factor or combination of factors? Mr. H. St. G. Anson conducted experiments extending over a period of some five months (1) to obtain instrumental evidence of some change in the electrical condition of the subject's skin concomitant to the variation of the percussion note, and second, to obtain graphical records of this acoustical phenomenon; and (2) to eliminate the possibility of the *apparent* change in the percussion note being due to the imagination of the observers. In respect of (2) "some measure of success was obtained, but the other part of the work proved entirely abortive." Yet it is hoped that these "entirely indeterminate" results "may prove of value in subsequent investigations into the physical nature of the phenomenon which it is hoped to undertake"!

A vigorous effort should be made to remove the restrictions under which Sir Thomas Horder's committee appears to have laboured, and to push the inquiry to a conclusion with the utmost expedition. The matter as it stands does no credit to scientific investigation.

### Geodynamic Problems of the Alps.

- (1) *Geodynamische Probleme*. 1: *Isostasie und die ursachliche Einheit von Gebirgsbildung und Vulkanismus*. Pp. 69 + 5 Tafeln. 5s. 3d. Teil 2. A: *Tektonik und Metamorphose*; B: *Die Widersprüche in der Kontraktionstheorie*. Pp. 51. 2s. 6d. Von Dr. C. G. S. Sandberg.
- (2) *Geotektonische Hypothesen: eine kritische Zusammenstellung*. Von Prof. Dr. Friedrich Nölke. (Sammlung geophysikalischer Schriften, No. 2.) Pp. viii + 128. 5s. 2d.
- (3) *Die alpine Faltung: ihre Anordnung in Raum und Zeit*. Von Dr. Hans Jenny. Pp. viii + 176 + 3 Tafeln. 13s. 2d.
- (4) *Geologie der zentralen Balkanhalbinsel: mit einer Übersicht der dinarischen Gebirgsbaus*. Von Prof. Dr. Franz Kossmat. (Die Kriegsschauplätze 1914-1918 geologisch dargestellt, Heft 12.) Pp. v + 198. 16s. 6d. (Berlin: Gebrüder Borntraeger, 1924.)

(1) **D**R. C. G. S. SANDBERG, of the Institute of Applied Geology at Munich, is well known from his geological work in South Africa, and his advocacy of the Kainozoic age of some Alpine granites. He is deeply impressed by the parallelism of folds in the crust belonging to very distant dates, and though this fact has been regarded as supporting the origin of mountains by the slow contraction of the earth, he advances a theory of mountain formation which rejects emphatically that contraction. He attributes the major earth movements to the action of isostasy, under the control of the internal heat. He considers that deep-seated thermal influences may prevent the movements that would be expected if isostatic equilibrium were due to simple changes at the surface.

The variation of the load on an area by denudation removing material from one place and depositing it in another, according to Dr. Sandberg, is counter-balanced by the accompanying thermal changes. The base of the crustal block from which a sheet of sediment has been removed is cooled by the exposure on the surface of a lower layer, and in consequence some of the molten sub-crustal material freezes on to the under side of the block and thus may counteract the thinning of the crust by denudation. At the same time the spread of the sedimentary material over the ocean floor raises the temperature of the subjacent material and leads to the base of the block being melted off, and thus the weight reduced. This process is probably one of the causes why denudation and sedimentation do not always lead to isostatic variations in level.

Dr. Sandberg further considers that in the great geosynclinals the crust becomes sodden with superheated water, which, being confined by overlying imper-

meable layers, produces intense pressure and, at a high temperature, causes widespread thermo-metamorphism of the rocks, while the lateral pressure produces earth movements and mountain building. That these processes would operate is generally recognised by believers in isostasy, but it is doubtful whether they would have so great an effect as Dr. Sandberg considers. The weakness of his case is his denial of the contraction of the crust. He admits that mountain folding would be inevitable if the earth contracts. He reproduces Lugeon's section of the overthrust masses in the Galmhorn; and such diagrams indicate that whatever may be the ultimate cause of the pressure, the actual movements are due to lateral compression, such as would be inevitable in a rigid crust surrounding a contracting mass.

Dr. Sandberg describes some ingenious experiments on folding movements produced during the bending of sheets of clay and asphalt; but such experiments on earth structure, like statistics, though always interesting as illustrations, prove nothing. The author's work is useful by directing attention to various influences that would attend or control isostasy, but are so uncertain that little direct reference has been made to them in the literature.

(2) Diametrically opposite to the main conclusion of Dr. Sandberg is that of Prof. Nölke. His work on geotectonic hypotheses is a critical summary of the many conflicting speculations of recent years. He remarks that the problem of orogeny is without doubt the most important, and the most difficult in the whole range of geology, and he subjects all recent theories on the subject to a critical examination.

In his preliminary chapter, Prof. Nölke discusses the problems of isostasy, the periodic nature of geological phenomena, and the causes of vulcanism and glacial periods. He also discusses the permanence of oceans and continents, regarding which he adopts the moderate view that though some areas of both land and sea may have been permanent throughout geological time, the variations in other parts have been too great to admit of the permanence of the chief geographical units. He also discusses movements of the pole, and concludes that they are restricted within very narrow limits. The polar and continental wanderings advocated by Wegener, he also rejects.

The main part of the volume consists of a statement and discussion of the various rival geotectonic hypotheses. Prof. Nölke concludes that the geological evidence is overwhelmingly in favour of the contraction of the earth as the main cause of crustal movements and mountain formation. The work is of great value from its careful summary of current theories and judicious conclusions of their merits.

(3) The modern literature on alpine geology is so extensive, and views have been developing so fast, that works which summarise one aspect of the subject are heartily welcome. Dr. H. Jenny, of Zurich, has prepared a short monograph on the distribution of folding east and west along the Alps, and its development in time. He adopts the view that the Alps consist of superimposed "Decken," and gives ample references to the literature on their structure; but he does not give the evidence as to their composition and the correlation of the rocks on which that theory rests. But adopting it, he correlates the various "Decken" and traces their evolution.

The theory dates back to Bertrand in 1883, who, however, afterwards abandoned his contribution to its foundation. Jenny abandons Suess's view of the asymmetric character of the Alps, and adopts Kober's conclusion that their northern and southern margins are more or less symmetrical. He has traced the movements which caused the "Decken" to a period much earlier than has been generally admitted. The story of the Alps goes back to the folding and intrusions of the Carboniferous, followed by the widespread volcanic eruptions of the Permian. The Trias was a period of geosynclinal subsidence with some deep-sea deposits. The Alpine compression began, according to Dr. Jenny, in the Pennine Alps during the Dogger, when the Lebendun, St. Bernhard, and Dent Blanche "Decken" were pushed to the north. These movements were almost confined to the Pennine Alps. They were resumed in the Middle Cretaceous, with the northward thrust of the Antigorio "Decke," contemporary with a similar movement in the eastern Alps. Further widespread northward thrusts happened during the Lower and Middle Eocene in the western Alps; there the Upper Eocene was a period of rest, though the effects of horizontal compression continued in the eastern Alps throughout the Eocene. Then in the southern Alps the lateral movements ceased; the Oligocene, Miocene, and Lower Pliocene were periods of faulting and fracture. In the northern Alps, however, the northward thrusts were continued and lasted until the Lower Pliocene.

The maintenance of the northern thrusts and overfolding on the northern side of the Alps while the southern Alps were subject to more or less vertical fracturing and subsidence has produced differences so important that they go far to justify Suess's claim for the asymmetry of the Alpine structure. The dynamo-metamorphic effects of these Decken movements are surprisingly slight. The old view of the Mesozoic age of the crystalline schists of the Alps on which so many early Alpine theories were based, has apparently gone for ever. Though Bonney is not mentioned, his conclusion that the pre-Cambrian schists are microscopically distinguishable from the dynamically crushed later

beds, is fully admitted. Dr. Jenny, for example, p. 100, says distinctly that the crystalline schists are pre-Cambrian, and his account of the metamorphism of the later beds shows that the changes have not produced rocks of the type of the old crystalline schist.

(4) The correlation of the Alps and the contemporary mountains of the Balkans is considered in Prof. F. Kossmat's geology of the Central Balkans. This book is one of the by-products of the War, for it is the twelfth of Dr. Wilser's monographs on the geology of the fields of war. It includes the results of the surveys of Macedonia, Serbia, and Albania by a large staff of German and Austrian geologists, of whom twenty-two are enumerated. Their work has been scientifically valuable, as they surveyed areas which were imperfectly known, and they collected much new information on the structure of the West and West Central Balkans. The results are of especial interest in regard to the Dinaric Mountains, to the Kainozoic of Macedonia, and to the relations of the Vardar valley, which Prof. Kossmat compares to the Briançonnais in the western Alps, as it is a Palæozoic and Mesozoic belt folded in between two masses of older rocks. These older rocks continue eastward through the Rhodope Mountains into Asia Minor.

The references to the German, Austrian, and Serbian literature are full, but there is no reference to British work on the area, though some might have been quoted with advantage. The problem of most general interest is that of the relations of the Dinaric-Balkan Mountains to the Alps. Prof. Kossmat insists that the Adriatic is a geosynclinal which dates back to the Mesozoic, and confirms the view that the Dinaric Mountains consist of tectonic blocks which have been thrust from the Balkans westward and south-westward, towards the Adriatic depression. Some of the thrust blocks are described as "Decke," but they have been moved merely for a short distance by reverse faults.

The author lays much stress on the importance of some overthrusts to the south, and these movements simplify Alpine structure. Thus, for example, Prof. Kossmat explains some inversions in the Hohe Tauern, where the Trias lies under the gneiss and schist, not as due to a far transported "Decke" having been brought from some unknown southern root, but as a simple thrust to the south and south-west of the old rocks of the Tauern arc.

That the Dinaric Alps are older than the younger eastern Alps which cut across them is now well established; and the Dinaric movements accord with the direction which is predominant in the Balkans, whereas in the western Alps the main movement has been to the north. The eastern Alps are an intermediate zone, which has been complicated by the movements having taken place in both directions.

J. W. G.

### Modern Metallurgy.

- (1) *The Science of Metals*. By Zay Jeffries and Robert S. Archer. Pp. xvii + 460. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 25s. net.
- (2) *The Corrosion of Metals*. By Ulick R. Evans. Pp. xi + 212. (London: E. Arnold and Co., 1924.) 14s. net.
- (3) *Cadmium: its Metallurgy, Properties and Uses*. By Dr. Norman F. Budgen. (Griffin's Scientific Text-Books.) Pp. xv + 239. (London: C. Griffin and Co., Ltd., 1924.) 21s. net.

(1) **T**HE subject matter of the book written by Messrs. Jeffries and Archer falls under the general heading of metallography. The authors inform us that about half of it has already been published in *Chemical and Metallurgical Engineering*, and that an effort has been made to make each chapter, to some extent, self-contained. One consequence of this is that there is a considerable amount of repetition. The authors are aware of this, but state that they do not consider this an objectionable feature, "since in general the material repeated is of such importance that it will stand repetition." As to this, opinions will perhaps vary, but it may be pointed out that the deformation of metals is treated in no less than six out of the twelve chapters of the book. The repetition, moreover, is not merely of the subject matter, but of the actual language used. Pages 149-50 are identical, word for word, with pages 403-5. Since the book is written by two Americans, there is a certain satisfaction in pointing out the work referred to in the above pages is English.

With the aim of the authors we have the fullest sympathy. Their starting-point is the fact that there is now a large body of scientific data as to the properties of metals and alloys but that few generalisations of fundamental importance have yet been reached, and that there is need for a proper classification and a more fundamental analysis of this knowledge. It is with this object that the book has been written. As already mentioned, the subject matter treated is that of metallography, but the authors have written a book which is not quite like any book on metallography that has yet been published. The keynote of their treatment is evident on p. 24, where they say "that there is an evident development of metallographic science in the direction of a thorough study of the constitution of matter." They are not content, however, to finish their analysis of structure where the microscope ends. They point out that the complete analysis of structure is concerned with the ultimate particles of matter, the electron, the atom and the molecule, and that it is not sufficient merely to recognise that such particles exist. Knowledge must be gained of the actual size of these

particles, of their properties and their relations with one another. "In this way a mental picture can be formed of the manner in which metals are built up and of the mechanism of the changes of structure and properties which affect their utility. The knowledge which is now available of the ultimate particles is not enough to make the pictures complete and accurate, but it is enough to make them useful."

The early part of the book deals with the conceptions of electrons, atoms, and molecules. From there the authors pass to a detailed treatment of the crystalline structure of metals, the amorphous metal hypothesis, grain growth and recrystallisation, the mechanical properties of metals, compounds of metals, metallic solid solutions, the constitution of alloys, the structure and properties of aggregates, some general considerations on the hardness of metals, and finally to the hardening of steel. This is an interesting field to survey, and, speaking broadly, the authors have treated the subject matter adequately. At any rate, they have written a book which will be read and carefully studied by workers in this field of knowledge. It is clear, stimulating, and suggestive. Here and there, however, its assertions do not accord with the scientific evidence available. On p. 164, *e.g.*, in dealing with the deformation of single crystals, the following sentence occurs: "Any deformation short of rupture produced by an external force, disappears on removal of the force." Such a statement is decidedly wide of the facts. Again, it is surprising to notice that the iron-carbon equilibrium diagrams published on pp. 307 and 317 entirely omit the  $\delta$  to  $\gamma$  change in pure iron and the low iron-carbon alloys. Connected with this is the statement on p. 88 that "if iron is cast it forms grains of  $\gamma$  iron above 900° C., crystallising with a face-centred cubic lattice." On the contrary, the iron solidifies as  $\delta$  iron (with a body-centred cubic lattice) and inverts at 1410° to the  $\gamma$  variety.

Chapter vi. with its account of the amorphous metal hypothesis is a fair statement of the position at the present time, but the succeeding chapter on grain growth and recrystallisation is scarcely fair to those who hold that there is a distinction between these two processes. The authors maintain that "Recrystallisation is grain growth" (p. 127), and again (p. 141) they say that in their opinion "no new crystal nuclei are formed during recrystallisation"; that is, in the absence of phase changes. There is, however, definite evidence tending to show that grain growth and recrystallisation are different processes, that the former is produced by very small stresses in the metal, followed by heat treatment, when certain crystals grow by absorbing others; while for the latter to take place much greater stresses are required, when new crystals

make their appearance in the crystal boundaries, and ultimately *all* the original crystals are destroyed by the growth of the new crystals.

Some interesting results are given on pp. 61 and 62, where it is pointed out that metals crystallising in face-centred cubes are ductile throughout a considerable range of temperature, even down to that of liquid air, and that these are the best conductors of heat and electricity. Both ductile and brittle metals are found in the body-centred cubic arrangement, while metals having the hexagonal close-packed lattice harden rapidly under deformation. The statement that "twin crystals have not been observed in aluminium" is not correct. It has been shown that, at any rate with single-crystal testpieces of aluminium, both broad or narrow twins can be obtained provided the orientation is suitable. The statement on p. 92 that the columnar grains formed when a metal solidifies in a chilled mould "are of course unstrained," is certainly not correct in this unqualified form. Such crystals very often are in a state of strain. The chapter on the structure and properties of aggregates is a suggestive survey of this subject, while the discussion of the hardening of steel by quenching contained in the last chapter is worthy of its great importance. The book is well printed and illustrated, and if it reaches a second edition, as we hope it will do, it would be greatly improved by suitable editing and some diminution in the number of repetitions.

(2) To Mr. U. R. Evans has fallen the distinction of writing the best book that has yet been written on the corrosion of metals. Some two and a half years ago he published a remarkable study, in four volumes, of metals and metallic compounds, in which he brought the most modern chemical and physical knowledge to bear on the properties of these substances. It may have been during his survey of this field that his attention was directed to the strange neglect of the scientific study of corrosion. It is only within the last twenty years that any serious attempt has been made to remedy this defect. The subject is one of great practical importance. From time to time estimates of a more or less sensational nature are published in the press as to the annual wastage of metals by corrosion. It is doubtful to what extent such estimates approximate to the real figure, but in any case it must be admitted that the loss due to this cause is very large. Moreover, as Mr. Evans points out, the evil which must have troubled mankind from the earliest times has tended to increase rather than to lessen with the passage of years. In early times, before the use of iron was general, the wastage was probably relatively unimportant, but since then, and particularly since the atmosphere has tended to be increasingly contaminated by the products of combustion of coal, the damage has been correspondingly intensified.

The first serious attempt to grapple with the corrosion problem was begun some fifteen years ago by the Council of the Institute of Metals, which set up a Research Committee charged with the task of finding a remedy for the corrosion of condenser tubes used in marine service. The more the problem was investigated by Dr. Bengough and his collaborators, the more did it become obvious that a wider and more fundamental knowledge of the nature of corrosion was required. From 1916 onwards this investigation was financially assisted by the Department of Scientific and Industrial Research, and a year ago the Department itself set up a committee to deal with this subject on the broadest lines. This committee is now at work. The impetus given in this way to the study of corrosion has extended to other bodies and other workers, and the literature concerning it is now large. Accordingly, the time was ripe for an attempt to be made to gather the scientific principles governing corrosion into a single volume.

This attempt has been made with signal success by Mr. Evans, and it is no exaggeration to say he has lifted the whole subject on to a new plane. He says, with truth, that "many chemists and engineers still seem to consider that it is impossible to find any guiding principle in corrosion. They appear to regard the destruction of metals as a more or less capricious phenomenon not governed by fixed laws in the same way as ordinary chemical reactions. Recent research, however, has shown that it is quite possible to explain why corrosion is set up at certain places and not others." This claim he justifies in his book. It opens with a historical survey and deals briefly with the earlier theories, namely, the "acid," the "hydro-peroxide," and the "electro-chemical." Attention is directed to Aston's notable paper published in 1916, in which it was pointed out that the reason why wet rust promoted further rusting was not that it acted as a cathodic contact material but as a diaphragm, screening the underlying metal from the direct access of oxygen. This led to the newer electro-chemical theory of corrosion, according to which electric currents are set up mainly by lack of uniformity in the distribution of oxygen, a theory which gives a rational explanation of many corrosion phenomena.

Succeeding chapters deal with the direct chemical combination of metals with non-metals, the passage between the metallic and ionic conditions, anodic corrosion by means of an externally applied current, corrosion involving the production of hydrogen gas, and corrosion involving the presence of dissolved oxygen. In view of its wide practical importance, a special chapter is devoted to the corrosion of copper and its alloys. Corrosion and tarnishing in a moist and polluted atmosphere and factors affecting the velocity of corrosion are next treated, while the last

two chapters are concerned with the various methods which have been devised for the minimisation and prevention of corrosion.

Mr. Evans himself is a research worker in the field of corrosion, and this fact gives his book a peculiar value, since it is written with a first-hand experimental knowledge of the subject, and many of his examples are taken from his own researches. There is no doubt that he is fully justified in adopting this course since there is great value in describing accurately phenomena which one has actually observed. The literature of corrosion contains many theories representing many points of view. Until recently something could be said for most of these, but with the clarification of the subject which has taken place particularly in the last two years, a considerable simplification of hypothesis and theory has been rendered possible, and to this Mr. Evans has himself greatly contributed. We congratulate him unreservedly on his book, and we think it will be heartily welcomed by all those for whom it is intended—the practical engineer, the works chemist, and the investigators engaged on research into corrosion and allied subjects.

(3) Dr. Budgen has written a useful book on the metal cadmium. It is the first of its kind which has appeared. Prof. Turner, who has written a foreword, states that cadmia was known to the ancients, and that metallic cadmium has been produced for more than a century. The present annual output of the metal is about 150 tons. It is mainly a by-product in the metallurgy of zinc and lead. This production could be considerably increased if more extended uses for the metal could be found. At present, however, its applications are of a minor character. It has considerable merit as a pigment but is too expensive for common use. Dr. Budgen considers there is a hopeful field of application in the anti-friction metals and in solders, as a substitute for either part or whole of the tin. The metal is being increasingly used in the form of a cadmium-copper alloy for telephonic, telegraphic, and power transmission purposes. The present volume constitutes a comprehensive digest of the available information with regard to this metal.

The early chapters of the book deal with the sources, metallurgy, and statistical information of the metal. Then follows an account of its physical and chemical and analytical properties, and this is succeeded by chapters on the binary, ternary, and quaternary alloys. Later chapters deal with the electrodeposition and uses of the metal. The book is included among Messrs. Charles Griffin and Co.'s well-known metallurgical publications. It is well printed and illustrated, and both author and publishers are to be congratulated on its appearance.

H. C. H. CARPENTER.

## Science and Religion.

- (1) *Science and Creation : the Christian Interpretation.* By the Rev. Charles F. D'Arcy. Pp. vi+126. (London : Longmans, Green and Co., 1925.) 3s. 6d. net.
- (2) *Contributions of Science to Religion.* By the Rev. Shailer Mathews. With the Co-operation of William E. Ritter, Robert A. Millikan, Edwin B. Frost, Edward B. Mathews, C. Judson Herrick, John M. Coulter, Ellsworth Faris, Charles H. Judd, John M. Dodson, Charles B. Davenport, E. Davenport, C.-E. A. Winslow, Horatio Hackett Newman. Pp. vii+427+5 plates. (New York and London : D. Appleton and Co., 1924.) 12s. 6d. net.
- (3) *New Light on Genesis : or Creation during Descent in the Scriptures.* By the Rev. Morris Morris. Pp. 151. (London, Edinburgh and New York : Marshall Bros., Ltd., 1924.) 3s. 6d.

(1) **T**HESE admirable lectures by Dr. D'Arcy, Archbishop of Armagh, display a notable capacity for keeping abreast of recent advances in science. On p. 17, for example, we discover the author's acquaintance with the new anthropological theories of the Perry, Rivers, Elliot Smith school ; he realises that culture degradation as well as progress has often taken place, and that the modern savage may not be by any means the equivalent of early man, so that the universal myth of a Golden Age may have its historical foundation after all (p. 14). The bishop also displays boldness, as well as clear judgment, in rejecting the specious attractions of vitalism in biology. It is not many religious apologists who would have dared to write words which might have come from Mr. Julian Huxley :

"The general conclusion is that, whether with the physiologist we consider the actual processes of the living body, or with the biologist we consider the evolution of living forms, the whole tendency of recent scientific discovery is in favour of the mechanistic view of the processes of life and against the vitalists who think it necessary to postulate a Specific Life Force" (p. 49).

Dr. D'Arcy does not make it quite clear whether it is only the thoroughgoing vitalism of Driesch that he is rejecting, or whether he repudiates also the modified, or "methodological" vitalism of Dr. J. S. Haldane ; but his discussion of hormones and glands leads one to imagine that he stands for a completely mechanistic physiology. It may be asked how, if one accepts such a point of view, room can be found for ideas of "purpose." His attitude seems to be similar to that of R. F. Hoernlé (to whom, however, he does not refer), or to that of L. T. Hobhouse ; the formula of the

former being "mechanism *plus* teleology," and of the latter, "we should not distinguish mind and matter as two substances, but teleology and mechanism as two modes of action."

The bishop's view is the legitimate one that function precedes structure. This may seem "Lamarckian nonsense," and leading back to all the superstitions of vitalism, but in point of fact it is an attempt to explain the evolution of structure by the experience which we have, in our own persons, of the actual modification of neural structure. Of this we actually have experience whenever we acquire a new habit, as neurologists like Sir Charles Sherrington and Dr. Henry Head have shown.

This part of Dr. D'Arcy's work will attract the biological student who has an interest in the philosophical implications of his science; but the psychologist will not find so much here to interest him. This is a pity, because the "conflict between religion and science" has largely shifted from biological on to psychological ground. Though a biological attitude necessarily leads to an equivalent psychological attitude (*e.g.* vitalism in biology means animism in psychology), yet we should have liked to hear Dr. D'Arcy's views on the bearing of the new psychology (and for that matter, the new anthropology) upon religion. "We are just getting the guns into position" is what one anthropologist is said to have remarked, and it is what a number of psychologists believe. These sciences seem to many people very menacing to religious faith; and the bishop does not help us much here. Nevertheless, we are grateful for a courageous, sincere, well-informed, and well-written book.

(2) Dr. Shailer Mathews' work has a very ambitious scope. The book is composite, and numerous authorities explain their own sciences and show how these have no hostile bearing upon religion. There are also some essays on the practical value of the natural sciences. Dr. Mathews contributes a valuable introduction, and four final chapters on religion as a personal adjustment to environment. It is to be hoped that this volume, so encyclopædic in the information it contains, and so broad in outlook, may be widely read in the United States.

(3) As for Mr. Morris Morris's "New Light on Genesis," biologists will suppose that the strength of his argument must lie in his exegetical chapters, whereas students of the Pentateuch will imagine they must lie in his criticisms of Darwin. We shall always lament that writers like Bateson, disappointed in their rather extravagant expectations from Mendelian theories, have given the impression that evolution was itself discredited, that is, that the *fact* of evolution, and not merely its *mode*, was in doubt. Mr. Morris Morris

solves the problem of the origin of variations by saying (p. 40) that they were supernaturally caused. But this is to offer a different type of explanation, and to introduce a different type of causality, from that which we have become accustomed to regard as scientific. It is equivalent to saying that there can be no scientific explanation. But this is to dogmatise; and men of science will not willingly take refuge in that *asylum ignorantiae*.

J. C. HARDWICK.

### Our Bookshelf.

*Les Échinodermes des mers d'Europe.* Par Prof. René Koehler. (Encyclopédie scientifique: Bibliothèque de Zoologie.) Tome 1. Pp. xiii + 362 + 9 planches. (Paris: Gaston Doin, 1924.) 16-50 francs.

HAVING published an excellent volume on echinoderms in the series "Faune de France" (see NATURE, vol. 107, p. 776, August 18, 1921), Prof. Koehler now undertakes to provide working naturalists with a guide to the echinoderms of Europe, both the littoral species and those that live on the continental plateau, as well as a few of the more interesting forms that have been dredged from greater depths. Since no such work has previously been published, the present one by so distinguished an authority will be warmly welcomed. It is to be in two volumes, of which this first one comprises the Asteroidea and Ophiuroidea, which are represented by 65 and 60 species respectively. The work is faunistic and essentially descriptive. Keys abound, and there are nine plates crowded with admirable photographs taken by the author and supplementary to those in the "Faune de France."

We have checked the accounts in various places, as occasion offered, and find them thoroughly practical. Here and there are statements that might be criticised. It is, for example, surprising to find so learned a zoologist still regarding the supposed *dorso-central* as a primary element in the echinoderm skeleton, and, what is worse, calling it the *centro-dorsal*—a totally distinct structure. He should also know that the term *ambulacra* was not given because of any connexion with locomotion. Or, to take a question of nomenclature, it is not clear why *Gorgonocephalus caput-medusæ* (Linnæus) should yield to the later synonym *G. lincki* (Müller and Troschel). Probably Prof. Koehler, who always gives 1841 as the date of Forbes's "History of British Starfishes," has not discovered that it was published in six monthly parts from October 1, 1840, to March 1, 1841. This may not be without importance. Such lapses as these, however, do not detract from the practical value of the book.

Preceding the systematic portion are some interesting chapters on the general morphology, development, phosphorescence, mode of life, parasites, and distribution of living echinoderms. The chapter on their palæontology is not quite abreast of modern views, but the notes on methods of preservation should be useful. At present rates, the book is remarkable value for the money.

F. A. B.

*The Ideal Aim of Physical Science: a Lecture delivered on November 7, 1924, before the University of London, at King's College.* By Prof. E. W. Hobson. Pp. iv + 34. (Cambridge: At the University Press, 1925.) 2s. net.

PROF. E. W. HOBSON has published in this booklet a lecture which he delivered in the autumn at King's College, London, and which is very well worth publication. He expounds briefly but clearly the view of the nature and necessary limitations of science, which received its most systematic development from Auguste Comte, but which Comte himself referred in germ to Hume. Mach, Karl Pearson, and Prof. Hobson himself are the most notable recent advocates of it, and it must be held to have made its case good, subject to a clearer definition of its meaning and limitation than have been given to it by some of its defenders in the past, not excluding Comte himself.

We keep "explaining" in science, pushing our explanation further and further back. What do we mean by "explanation"? On this point those who become interested in Prof. Hobson's pamphlet should go on to Meyerson's "*Explication dans la science*," where this very point is submitted to a most searching historical examination. How far does this descriptive theory of science itself involve metaphysical elements, that very reasoning about the nature of things in themselves which it seeks most carefully to exclude? What do we mean by the "nature of things-in-themselves," and what would be the basis of philosophy if it is to be so sharply severed from science as Prof. Hobson demands?

Broadly speaking, while agreeing with him in his general thesis, on the basis of the old ideas of a separate, metaphysical world of things-in-themselves, we cannot agree that the spheres of science and philosophy can be thus regarded as independent. Philosophy is rather the "science of sciences," the most general conclusions of all which we can reach, while pursuing the strict path of science as the school to which Prof. Hobson belongs would describe it. But this is far too large a subject for a short note. Prof. Hobson's pamphlet is an admirable provocative to further thought, and concludes with an enlightening account of Einstein's work as illustrating his general position.

F. S. MARVIN.

*Martin Arrowsmith.* By Sinclair Lewis. Pp. 480. (London: Jonathan Cape, Ltd., 1925.) 7s. 6d. net.

It is not often that a novel calls for review in a scientific journal, but Mr. Sinclair Lewis has given us in "*Martin Arrowsmith*" a work of such interest and importance that notice of it should not be neglected. It is a long novel dealing with the life problem of a young medical student and practitioner in the United States, who is handicapped by the common difficulty of narrow financial straits. He is inspired by the fine fire that consumes the true research worker to the exclusion of all else, and perpetually has to fight his superiors, who demand practical results and cannot see the importance of fundamental research *per se*. If the book brings home to any of the public the force of this idea, as it surely must, then it will do a very great service to research.

The other characters are remarkably well drawn, and though the "two-fisted fighting poet Doc" Pickerbaugh, of a State Public Health Service, may appear somewhat of a caricature to British eyes, doubtless he has his prototypes in the newer civilisation of America. Max Gottlieb, the bacteriologist, is excellent, and his gospel of truth so well set out that it should be an inspiration to many others who choose the hard paths of research as it was to Martin Arrowsmith.

What is called the "human interest" is not neglected, but we can see that Mr. Lewis was much more interested in the relation of Martin's emotional life to his work than to the mere story of it; viewed only as a tale, however, it makes excellent reading.

In a preliminary note, the author acknowledges the help of Dr. Paul de Kruif afforded him with the medical parts of the work, and with his scientific philosophy, and we can only say we should be glad to meet this gentleman. Mr. Lewis showed great promise in his earlier work, but here he has surely found himself, and we have no hesitation in strongly recommending this book to all research workers. W. P. K.

*Über Wärmeleitung und andere ausgleichende Vorgänge.*

Von Prof. Dr. Emil Warburg. Pp. x + 106. (Berlin: Julius Springer, 1924.) 1.40 dollars.

THE idea of making the theory of heat conduction in solids serve as an introduction to the theory of all diffusion or levelling processes is a good one and saves a large amount of repetition of mathematical work. The use of the term thermal resistance (p. 11) in the same sense as its analogue electrical resistance is another good feature of the book. More use of the point source is made than has been customary in books on heat conduction, *e.g.* the heat section of Riemann-Partielle Differential-gleichungen. In applying the elementary theory to cases like the deposit of dew (p. 32) and the bolometer (p. 34), in which the conditions are not such as to give direct conductivity problems, the author has detracted somewhat from the value of his work for teaching purposes. The same may be said of the transition from the periodic flow of a temperature wave into the earth to the periodic change of concentration at electrodes through which an alternating current enters a solution (p. 55). Only a page (p. 64) is devoted to diffusion, and no hint is given as to the motion of the solvent. Viscosity gets twenty pages, too many of which are devoted to the old oscillating disc method.

*Islands: West Indian—Ægean.* By Sir Arthur E. Shipley. Pp. xii + 139 + 24 plates. (London: Martin Hopkinson and Co., Ltd., 1924.) 6s. net.

SIR ARTHUR SHIPLEY has reprinted in this volume a number of short newspaper articles which he contributed to the *Times* and other journals on a recent visit to the West Indies, and a cruise among the islands of the Ægean Sea. Tropical agriculture takes a prominent place in the volume, but other interests find a place. There is enough in the brief volume to make the reader ask for more, but all too little to satisfy. The chapters on the Mediterranean Islands especially are tantalisingly hurried.

## Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.*]

### Quantum Radiation.

THE fraction  $\kappa/(e^{\kappa}-1)$ , by which the quantum theory of radiation differs from the classical theory, is so important that it seemed of interest to study it for its own sake. I accordingly wrote to my brother Alfred Lodge, as a pure mathematician, asking him what he had to say about it. He directed my attention to some points which may be of interest to other students of Planck's theory as expounded in Great Britain by Dr. Jeans. First, that the function was studied by John Bernoulli and expanded in a series involving his particular numbers; and next, that it is the ratio of simple interest to continuous compound interest for the same period. Or in other words, the compound interest  $h\nu$  on  $E$ , the actual basic energy, is equal to the simple interest on  $RT$ ; so that  $E$  has to be reduced below the average value in order to allow compound interest to be taken on it, while the rate of interest,  $\kappa$ , is apparently dependent on the ratio  $\nu/T$ .

The expansion spoken of above runs thus:

$$\frac{\kappa}{e^{\kappa}-1} = 1 - \frac{1}{2}\kappa + \frac{1}{6}\frac{\kappa^2}{2!} - \frac{1}{30}\frac{\kappa^4}{4!} + \frac{1}{42}\frac{\kappa^6}{6!} - \frac{1}{30}\frac{\kappa^8}{8!} + \dots$$

the coefficients being the successive Bernoulli numbers. A peculiarity of this series is that there are no odd powers of  $\kappa$  after the first; looking as if everything outside classical mechanics depended on square numbers, like the radii of Bohr orbits.

Apart from the expansion so well known to pure mathematicians, the physical suggestion is that while  $RT$  is the average energy per degree of freedom per atom, the actual individual atomic energy  $E$  accumulates continuously at compound interest, the rate of which is  $\kappa = h\nu/RT$ , until some atom has attained the extra accumulation  $h\nu$ , which it then emits. So that  $E(e^{\kappa}-1) = RT\kappa = h\nu$ .

Interest is compound until it is paid, and then begins again. Thus  $E$  is first left to grow until it equals  $Ee^{\kappa}$ ; then  $E(e^{\kappa}-1)$  is given out, and  $E$  is left to grow again until it again equals  $Ee^{\kappa}$ , when another dividend is paid.

The accumulating unit is the atom, the energy of which is  $RT$  or  $3RT$  only on the average. The actual energy rises by the compound interest of thermal agitation, until an emission occurs from those which on the ground of probability have reached the critical stage: small emissions at low frequency, large emissions—if they can occur—at high frequency.

The energy  $E$  is presumably internal electronic energy, the only kind of disturbance which can affect the ether and either radiate or absorb. It is doubtless associated with some particular frequency of revolution or internal vibration. Mere molecular or mechanical energy alone would not radiate (matter alone has no link with the ether); if it did we should have the equi-partition law and its troubles. Even the internal mechanism does not radiate save in jumps or jerks. Within the atom the energy grows continuously, but it is given out spasmodically.

All this is suggestive, and may probably be put in an educational manner. I need scarcely emphasise the singular beauty of the modern theory of black-

body radiation, and the fundamental way in which we are beginning to get down to the mode of interaction between matter and ether.

OLIVER LODGE.

May 9.

### D. C. Miller's Recent Experiments, and the Relativity Theory.

EVIDENCE against the validity of the relativity theory was unfolded before the annual meeting, April 28, of the National Academy of Sciences by Prof. Dayton C. Miller, of the Case School of Applied Science, who, by a much-refined and improved repetition of the so-called Michelson-Morley experiment, has shown that there is a definite and measurable motion of the earth through the ether.

Prof. Miller has obtained on four occasions a small positive effect at Cleveland, namely, the equivalent of a velocity of about 2 kilometres per second at the altitude of the Case School of Applied Science, and about 3 kilometres per second on the level of the neighbouring hills. Whereas at the altitude of the Mount Wilson Observatory, in four consecutive experiments spread out over four years, he obtained with increasing precision a positive result of 10 kilometres per second, his last result this April justifies him in asserting that the result is correct to within one-half kilometre per second.

The technical details of these experiments themselves will be described shortly in special papers by Prof. Miller himself. The purpose of the present letter is to say a few words about the implications of these results from the point of view of the relativity and the ether theories.

In the first place, then, this definite result is entirely antagonistic to the Einstein relativity theory, which in fact could not be adapted to the results of Prof. Miller by any conceivable modifications, unless the very fundamental principles of Einstein's theory were given up. This, however, is as much as to say that Miller's results knock out the relativity theory radically.

In the second place, from the point of view of an ether theory, this set of results, as well as all others previously discovered, are easily explicable by means of the Stokes' ether concept, as modified by Planck and Lorentz, and discussed by the writer in a *Phil. Mag.* paper (1919).

Without entering into the mathematical details associated with this statement, we may say only that Prof. Miller's results, as obtained in Cleveland and Mount Wilson, are given immediately by the main property of such an ether, namely, to adhere almost completely to the surface of the earth, and therefore to share almost entirely its translational motion over its surface, and to have a gradually increasing velocity relative to it when we go higher and higher up.

In the third place, the result of the recent *rotational* terrestrial experiment at Clearing, Ill., near Chicago, which gave a full effect associated with the spinning motion of the earth, can be accounted for by making the natural assumption that our globe, being almost perfectly spherical and having a purely gravitational grip upon the ether, does not appreciably drag it in its rotatory motion. Also the deflexion of the light rays around the sun to the amount claimed by the Einstein formula can be easily accounted for by means of a compressible ether provided its dielectric constant is related to its density and pressure by a very simple formula published by me a few years ago in the *Philosophical Magazine*.

The amount of additional evidence for the reality of Prof. Miller's beautiful results afforded by his tables

showing the relations of the observed azimuths of drift to the sidereal time is very remarkable. These tables indicate a motion of the solar system in a direction and with a velocity in good accordance with the independent results obtained by Dr. Strömberg and others.

LUDWIK SILBERSTEIN.

Washington, D.C., April 30.

### Phylogeny as an Independent Science.

UNDER the title "Phylogeny as an Independent Science," E. W. M. gives in NATURE of December 20, 1924, a critical review of my "Geschichte der Organismen." Some points in this review cannot be passed without comment.

Almost at the beginning, the reviewer sums up the tenor of the book in the words: the author "treats of the evolutionary history of every phylum both in the animal and in the vegetable kingdom!" He has thus neither learned from the title, preface, and contents of the book, nor communicated to the reader of the review, the fact that "Geschichte"—that is, history—is not identical with "evolutionary" history. In my mind, the history of organisms tends to follow three courses, namely: (1) a simple account according to the chronology of the fossils and to the recent changes of fauna and flora; (2) showing the superiority of differentiation and centralisation (integration, Herbert Spencer), in contrast with the inferiority of differentiation alone; (3) phylogenetical connexion, the latter being the hypothetical part of the history. Thus the reviewer apparently did not understand that this mode of treatment leads, among other things, to securing, for his part, in good cases phylogeny more dependent than hitherto on empirical chronology, and to gain perhaps here or there an adaptation to each other of isolated phylogenetical hypotheses.

Furthermore, the reviewer enumerates two themes, of which he laments the absence of any attempt at explanation in the book. Well, the law of recapitulation is by no means explained in detail, but "the value and the limitations of the evidence from fossils" is discussed in a distinct manner in what to me is one essential respect, namely, that, on the average, the number of fossils diminishes at an accelerated rate when we go down to the older geological formations, and that, where it completely vanishes in pre-Cambrian times, we are still in a period approximately recent relative to the periods of origin of life, as well as of forming the chief branches of the genealogical tree.

Concerning the phylogeny of the Turbellaria, the reviewer says: "Not a word is mentioned of Lang's brilliant theory of their derivation from Ctenophora . . ." etc. This theory, however, is mentioned in the book, pages 305-6, in the chapter on the Ctenophora, in some twenty lines, where I say that it seems to me "somewhat too distinct." Moreover, the more recent view of Wilhelmi, perhaps not yet known to the reviewer, is recorded and adopted. The same theory is briefly mentioned again on page 659, in order to compare the hypothetical place of the creeping ctenophores with that of the dipnoid fishes and that of the Bennettit plants.

The reviewer remarks, "how ill-founded is Franz's comparison of the cystid and the echinoid because both have a spherical shape." The book, however, says that probably the echinoids were derived "from cystids with five short arms." Therefore, according to my meaning, these cystids, besides the ancestors of those known as fossils, were not spherical, as also

in the greatest number of fossils the arms are only broken off.

With this, to be sure, I do not wish to deny that the reviewer's objection, that the sucker of attachment of asterid larvæ is identical with the attachment of the stalk of the crinoids, can be right; and here again, if I may add in short a phylogenetical consideration, I should not believe Bury's and the reviewer's phylogeny of the Echinodermata to be persuading, nor should I mean that F. Mueller's and the reviewer's interpretation of the Nauplius (ancestral) is more suggestive than mine (modified metatrochophora). As to the Echinodermata, I do not understand how it can be overlooked that by far the greatest probability is in favour of the origin of the radiometry of this great phylum in fixation, since fixation has effected all other radiometry, or, at any rate, nearly all others, in the animal and vegetable kingdom, and since Balanoglossus, the creeping allied form to the echinoderms, is not radial. There is a striking parallelism: annelids→brachiopods, enteropneusts→echinoderms, if we assume that the non-radiometry of the brachiopods has caused lower vitality or victoriousness and the less modulation of these animals also fixed, compared with the echinoderms. To present such ideas, connected with each other, though in many cases partially hypothetical, and surely to be in future again adapted to the considerations presented from other points of view, is to be one of the tasks of the "history of organisms."

As to the Nauplius, the identification, though only approximate, of a living marine larva with a Cambrian fossil would be strongly against the tendencies of the book, and to the intentions of the author. Moreover, I see no essential resemblance between the four-segmented Nauplius and the multisegmented Cambrian Marrella, without regard to the question whether this interesting form, perhaps nearly the missing-link between brachiopods and trilobites, could have been mentioned in the book.

V. FRANZ.

Zool. Inst. and Phylet. Museum,  
Jena.

I AM sorry if I misunderstood the objects aimed at by Prof. Franz's book, "Die Geschichte der Organismen." I admit that the German word "Geschichte" is capable of being understood in two senses, namely, (1) a general descriptive account, and (2) evolutionary history. Since Prof. Franz holds the chair of phylogeny in his university, I understood "Geschichte" in the latter sense. All I can say is that if he intended it to be understood in the former sense, a task of such gigantic dimensions could not be attempted in a work of the size of his book. I gather that he intended to bring phylogenetic hypotheses into relation with fossil discoveries; in this aim I am in entire sympathy with him, however little success may have attended his efforts.

The object of my review was thus to point out that phylogenetic theory must remain a matter of personal taste, until the foundations on which it should rest are discussed and defined. These foundations are, as it seems to me, three, namely:

(1) When a number of closely allied species or genera are compared together, the more specialised amongst them have been evolved from the more generalised.

(2) When a close succession of allied fossil forms has been discovered in the same locality, becoming gradually changed as we pass from older to younger beds, this indicates a true evolutionary series.

(3) When the same larval form is found in the life

histories of diverse members of the same great group, it represents in modified and simplified form a common ancestor; and when the youth forms of certain members of a group closely resemble the adult forms of allied members of the same group, then these youth forms give the original structure of the allied species.

Now (1) is still able to shed strong light on the course of evolution when used with great care by our systematic experts; but its value is far more limited than was formerly supposed; its use implies that one living adult form has remained unchanged whilst other allied ones have progressed or degenerated, and this assumption is an exceedingly dangerous one, as leading palæontologists like my friend Dr. Bather have repeatedly pointed out. One has only to read Huxley's "Invertebrate Zoology" to see to what amazing conclusions the use of this method led even such a sagacious zoologist as Huxley fifty years ago.

(2) was regarded by Huxley as the best and most conclusive evidence for evolution, and in this I cordially agree with him: its range, however, is excessively limited. Such series are known only in a few cases; and only animals with hard parts intimately related to their general organisation can give by their fossil remains any real information as to the course of evolution. It does not help us at all with soft-bodied forms like Turbellaria and Annelida, and even in the case of Mollusca it gives no information as to the course of the evolution of the internal organs. Moreover, as Franz himself admits, the fossil record begins abruptly at a time when the main phyla were already differentiated.

(3) has the widest range of applicability if the biogenetic law is sound. But no one, even the most enthusiastic supporter of recapitulation, has denied the action of secondary simplifications and modifications in changing life history; and it seems to me that the task of a professor of phylogeny should be to analyse and discuss these secondary modifying factors.

Such factors are, for example:

(1) The changes involved in transforming a larval into an embryonic type of development.

(2) The distorting effects of yolk and of maternal nourishment by a placenta.

(3) The tendency to represent in life history only the functionally more important organs of the ancestor and to leave the less functionally active entirely unrepresented.

Now I may briefly allude to the cases cited in my review where Prof. Franz arrived at what I consider to be erroneous conclusions owing to the neglect of these principles.

These are the origin of the Turbellaria, the descent of Echinoids, and the significance of the Nauplius larva in Crustacea.

(1) Lang's theory of the origin of Turbellaria from Ctenophora is based on a careful comparison of the larvæ of the two forms, and that Ctenophora can take up creeping habits and become profoundly modified in the way in which Lang suggests is demonstrated by the recent genera *Ctenoplana* and *Cœloplana*. The latter of these has a "ctenophoroid" larva as Kumai has recently proved. The opposing theories favoured by Prof. Franz are based on crude comparisons of the adult forms of Turbellaria and Mollusca.

(2) Prof. Franz is mistaken in supposing that my main objection to the supposed cystid origin of Echinoids is that this theory is based on the superficial resemblance of a globular shape in the two groups. The Cystid is a *Pelmatozoon*, that is, a form which typically has a stalk for attachment situated in the centre of the aboral surface opposite the mouth.

The Echinoid when young is an Asteroid, the globular shape is non-existent, and the radial canals stretch horizontally outwards from the mouth. The globular form develops as it grows older. I speak from constant observation as I have Echinoids undergoing metamorphosis in my laboratory every year. At no period in the life history is there an indication of a fixing organ in the aboral region: in the Asteroidea such an organ is developed on the oral surface.

(3) The Nauplius larva represents in some form a common ancestor of the Crustacea, since it appears in life histories of members of such divergent groups as the Euphausioidacea, the Malacostraca, the Cirripedia, the Copepoda, the Ostracoda, the Cladocera, and the Branchipoda. It possesses few visible segments, but it is already an arthropod with stiff cuticle and jointed legs moving like oars, in this respect differing from all Annelida. It is, however, not a crustacean, for by definition the Crustacea have two pairs of præoral appendages and at least two pairs of limbs converted into jaws, whilst the Nauplius has one pair of præoral appendages and no true jaws. The Trilobita were Arthropods of just these characters; they had a single pair of antennæ, and all the post-oral limbs were alike, each provided with the rudiment of a jaw-blade but none converted into jaws, and all the limbs were of a simple foliaceous character. Now in Marrella as described by Walcott, which belongs to one of the oldest fossil faunæ known, we find the Trilobite antenna, but amongst the post-oral appendages the first two corresponding to the Naupliar post-oral second antenna and mandible are greatly enlarged forked limbs, whilst the more posterior limbs remain in their primitive foliaceous condition. Except for these latter limbs Marrella is a Nauplius, and the absence of the hinder undifferentiated limbs in the modern Nauplius larva would surprise no one acquainted with comparative embryology. Since, moreover, Marrella is intermediate in structure between Trilobita and Branchipoda, as Prof. Franz justly asserts, this constitutes one more argument for regarding it as the ancestor of Branchipoda and of Crustacea in general which is represented in ontogeny by the Nauplius. E. W. M.

### The Orientation of Stonehenge.

SOME persons have supposed that the intentional orientation of Stonehenge is a theory invented by Sir Norman Lockyer. As a matter of fact, it has been the opinion of every authority who has dealt with the subject from an astronomical point of view for the last two hundred years.

Owing to the gradual change in the obliquity of the ecliptic, the point on the Stonehenge horizon at which midsummer sunrise occurs is, in the course of time, slowly shifting to the eastward. At some time in the remote past the point of sunrise, viewed from the Stonehenge site, would have been beyond the azimuth of the axis line on the northern side. The midsummer sunrise now occurs to the east of the axis line, having passed that azimuth some thousands of years ago.

At some date in the past, therefore, the midsummer sunrise undoubtedly occurred at a point on the horizon in line with the axis of Stonehenge. This is not a theory, but is an absolute astronomical fact depending on the physical constitution of the solar system.

It is generally agreed as probable that the builders of the present structure of Stonehenge directed its axis, as nearly as they were able, to the point on the

horizon at which midsummer sunrise occurred at that date.

To enable us to discuss intelligently the probability of an *intentional* orientation by the Stonehenge builders, it is necessary in the first place to ascertain the approximate date at which midsummer sunrise actually occurred in line with the axis. This problem has been dealt with from time to time by different experts, and most completely by Sir Norman Lockyer. The methods adopted for this investigation are set forth in the present writer's recently published work on Stonehenge, in the chapter on "Astronomical Considerations," to which the reader is invited to refer.

On the data there set forth Lockyer found the obliquity of the ecliptic which would cause midsummer sunrise to take place at a point on the horizon on the line of the axis to be  $23^{\circ} 54' 30''$ . According to Simon Newcomb (the eminent American astronomer) the date at which the ecliptic made this angle with the equator was about 1840 B.C.

Owing to want of precision in the data Lockyer considered that the possible error might affect the date to the extent (plus or minus) of as much as 200 years. We may conclude, therefore, that—as determined by astronomical considerations—the date at which midsummer sunrise occurred on the line of the axis of Stonehenge was sometime between 2040 B.C. and 1640 B.C.

Now it will be observed that this is just about the date now generally agreed by archæologists as the probable date of the building of Stonehenge.

We may conclude, therefore, that the builders of the present structure of Stonehenge did, as a matter of fact, direct the axis of their new building, either exactly or very nearly, to the point on the horizon at which the sunrise at midsummer then took place. It may, of course, be contended that this remarkable agreement is a mere chance coincidence. The fact, however, remains as stated.

The accuracy of Sir Norman Lockyer's calculations has never been questioned, and the results obtained can readily be checked by any competent computer. The margin of error (200 years either way) appears sufficient to allow for any want of precision in the data.

E. HERBERT STONE.

The Retreat, Devizes,  
May 1.

#### A Stranded Cetacean.

A BRIEF account of the stranding of a Cetacean in the neighbourhood of Langness, Isle of Man, will probably interest many readers of NATURE. This event was reported to me and my colleagues on Saturday, May 9, and in the afternoon of that day I accompanied Mr. J. R. Bruce to the spot, which is a small creek on the Langness peninsula. Here we were joined by Mr. P. M. C. Kermode, Curator of the Manx Museum, Douglas, and along with him we obtained a good series of measurements and photographs. From these we conclude that the specimen is a rorqual (*Balænoptera* sp.), but this identification awaits confirmation. From the measurements obtained I select the following: Length, from tip of upper jaw, along back, to notch between tail-flukes, 48 ft. 6 in.; breadth of tail, from tip to tip of flukes, 11 ft. 8 in.; tip of upper jaw to centre of eye, 9 ft. 8 in.; length of pectoral fin, anterior insertion to tip, 5 ft. 6 in.

H. C. CHADWICK.

The Biological Station,  
Port Erin, Isle of Man,  
May 11.

#### Lightning.

EVER SINCE I was a child I have heard of the idea that lightning makes a "swishing" noise when one is quite close to it, but I have looked on this as a popular superstition. I have recently, however, had occasion to wonder whether there may not be some foundation for the idea. On April 24 there was a very severe thunderstorm here, quite a number of flashes having been within a kilometre and a half of this house, a barn was struck one kilometre away, and probably also a cottage 450 metres in another direction. During the storm three men were working in a field; two of them were together close to a holly tree in a hedge; there was a very bright flash of lightning, with a just perceptible interval between the flash and the thunder. At the moment of the lightning there was quite a loud swishing sound in the holly tree, as though, they said, a sudden blast of air went through the tree; the sound occurred definitely before the thunder.

At about the time of the occurrence the wind rose to 30 miles per hour and gradually fell off to about 13 miles per hour; both men, however, are positive that there was no wind at the time, but that it got up shortly afterwards when the rain began. The flash must have been very close as they both smelt "sulphur"—nitrogen peroxide; and they could scarcely see anything for some moments. The third man was about 230 metres away and was close to an oak tree to which he had his back; he says that when the flash came there was a noise in the tree as though it were "on fire." He turned round expecting to see that it had been struck, but neither oak nor holly showed any signs of having been struck. Is it possible that in the neighbourhood of a flash, brush discharges may take place from trees and other points?

C. J. P. CAVE.

Stoner Hill, Petersfield, Hants,  
May 12.

#### Decay and Regeneration of Radio-luminescence.

IT IS well known that the luminescence produced in certain materials subjected to the action of the radio-active rays decreases with time and that the colour of the luminescence changes, while at the same time the material itself also changes in colour. From experimental work covering more than two years and still under way, we are led to believe that the decrease in luminescence of phosphorescent zinc sulphide, etc., is probably due to the masking of the radiation luminosity by the colour which the material acquires, due to the action of the radiation.

For example, small glass tubes containing radon initially glow quite brightly with a yellowish-green light, but the glass soon turns either brown or blue, and in the course of a few days the tubes glow very faintly, if at all. If the tubes be heated sufficiently just to discharge the coloration, the glow returns. This operation can be repeated with no apparent change in the property of the glass to glow under the action of the radon rays.

The coloration of the glass is not a surface phenomenon, and the colour produced, whether brown or blue, seems to reach a colour depth beyond which further radiation produces no apparent increase in the coloration.

Since the observation of the behaviour of glass under radiation and the restoration of its luminescence by discharging the coloration by heating, phosphorescent zinc sulphide has been investigated. Here again the visible radio-luminescence and the

phosphorescence decrease as the coloration increases, and eventually zinc sulphide, which originally gave a brilliant phosphorescence in daylight, no longer responds, and it is only faintly responsive to alpha radiation. However, on heating this zinc sulphide just sufficiently to discharge the coloration, no difference in any of its properties can be detected between such revived zinc sulphide and some of the same material which has not been subjected to radiation.

This investigation is being continued and a more detailed report will be given later.

CHARLES H. VIOL.  
GLENN D. KAMMER.  
ARTHUR L. MILLER.

Radium Research Laboratory,  
Standard Chemical Company,  
Pittsburg, Pennsylvania,  
April 13.

### Hydra and the Tadpoles.

THE following observation was made by Mr J. T. Wadsworth, the steward of the zoological laboratory in the University of Manchester.

On April 25 a tadpole in a small aquarium was seen to be behaving in an unusual way. It was swaying to and fro with its head down, and appeared to be attached to the side of the aquarium by its tail. Further observation showed that it had been captured by a hydra and was held securely by the tip of its tail. The movements of the tadpole became feebler and feebler, and in half an hour they ceased altogether, the tadpole being evidently dead or completely narcotised. A quarter of an hour later, as no further signs of vitality appeared in the tadpole, the hydra with its enormous prey was carefully detached from the side of the aquarium and preserved in Carnoy's fluid.

The accompanying illustration (Fig. 1) is a repro-



FIG. 1.—A tadpole 9 mm. in length, captured and killed by a hydra. The hydra is seen in a contracted condition, attached to the tip of the tadpole's tail.  $\times 8$ .

duction of a careful drawing to scale made by Miss M. Jepson of this preparation. As this is the first recorded case, I believe, of a tadpole of this size (9 mm. in length) being captured by a hydra, it is probably not a common occurrence. The question might, therefore, arise as to whether the tadpole was in a normal healthy condition. It may be remarked that, as the hydra was attached to the glass about half-way between the surface and the bottom of the aquarium, the tadpole must have been captured while swimming, and when first observed the movements of the tadpole were fairly vigorous. In any event, it is a very remarkable illustration of the strength of the hydra's grasp and probably also of the toxic powers of the nematocyst fluid.

SYDNEY J. HICKSON.

University of Manchester,  
May 4.

### Rainfall Correlations in Trinidad.

IN connexion with my communication to *NATURE* (February 7, p. 192) on the above subject, it may be of interest to mention that I have recently received a letter from my friend, Dr. Preston E. James, Department of Geography, University of Michigan, informing me that at the meeting of the Association of American Geographers at Washington last December, he recorded in an address on "Geographical Factors

in the Trinidad Coconut Industry" certain correlations between rainfall and coconut yield. In connexion with data obtained from a large estate in the extreme south-east of the island, he found a positive correlation between the rainfall of one six-month period and the *quality* of the nuts six months later, "quality" being a matter of the proportion of selected nuts—which will not pass through an iron ring 4 inches in diameter—and "rejects" and "culls"—or those that will. (Thus grading into "selects" and "culls" is the recognised commercial practice where coconuts, as nuts and not as copra, are exported to northern markets.) Dr. James claims to have found a positive correlation of  $0.733 \pm 0.072$ . The correlation for the same six-month period, that is, without any lag, was  $0.508 \pm 0.109$ .

In my communication to *NATURE*, which dealt mainly with my own investigations in regard to rainfall and cacao yields, I gave the impression that rainfall and coconut yields had not been studied, being unaware of Dr. James's work, which has not yet been fully published.

Dr. James's work evidently constitutes a useful contribution to our knowledge of Trinidad's economic geography, and I presume that it is of considerable botanical interest to learn that the size of the coconut (not the entire drupe, but the endocarp and endosperm) is closely associated with rainfall, and that the extent of the relationship has been statistically determined under certain conditions.

W. R. DUNLOP.

34 Kensington Court,  
London, W.8, March 26.

### On the Spark Spectrum of Tungsten in a Helium Vacuum Arc.

PROF. O. W. RICHARDSON, in a paper entitled "The Striking and Breaking Potentials for Electron Discharges in Hydrogen" (*Proc. Roy. Soc.* 106, p. 640, December 1924), comments on the interesting fact that when a barium coated cathode burned out in an atmosphere of hydrogen, the spark lines of barium were developed instead of the arc spectrum.

We have observed a very similar phenomenon in which a hot tungsten cathode used in the operation of an arc at low pressure in pure helium is capable of developing the spark spectrum of tungsten. The conditions necessary for the development of this spectrum do not require temperatures high enough to burn out the filament; but the lines invariably make their appearance when it is raised to dazzling incandescence either by the thermo-ionic bombardment of the helium, or by a direct heating current, or preferably, by both. The relative intensities of the lines are distinctly modified from those given in the standard tables of wave-lengths, which fact is doubtless to be attributed to the presence of helium. For this reason, one has to go to some pains to be certain that the lines are those of the tungsten spark spectrum. Mr. S. J. Metzler has recently, in this laboratory, established this fact beyond a doubt.

Because of the wide use of the spark lines of refractory metals as secondary standards in wave-length determinations, and the difficulties encountered by various workers in this important field, with respect to precision determinations of these wave-lengths, due to pole effects and pressure shifts, it may be that the production of the spark spectra of these substances in helium vacuum arc conditions will enable them to be used with much greater reliability.

HARVEY B. LEMON.

Ryerson Physical Laboratory,  
The University of Chicago, April 22.

## The Story of the Mont Blanc Observatories.

By Dr. A. E. H. TUTTON, F.R.S.

THE announcement of the death of Joseph Vallot, the founder and director of the permanent observatory on Mont Blanc, at the age of seventy-two years, at his residence in Nice, will doubtless render the following account of some special interest. After I had made a particularly memorable ascent to the summit of Mont Blanc in magnificent weather on August 9, 1923, spending some time, both on the ascent and on the return to Chamonix, at the most welcome refuge and observatory of M. Vallot on the rocks of the Rocher des Bosses, at the height of 14,312 feet—it was obvious that the veteran mountaineer and scientist was in failing health—I was fortunately able to persuade M. Vallot to put the salient facts regarding the Mont Blanc observatories in writing. M. Vallot responded most kindly, and prepared a typed and signed statement, which is now of such interest and importance that it has been freely translated and embodied, with some additional facts of earlier date, in the following account. Indeed, M. Vallot gave special permission, almost a request, that its essence might be contributed either to *NATURE* or to the Royal Astronomical Society, and it is with great pleasure that this account is now at last written, although the sad circumstance of M. Vallot's passing from the magnificent scene of his life-work on Mont Blanc, in the valleys around which he will be greatly missed as a munificent friend and benefactor, renders the occasion one which the scientific world will deplore.

The summit of Mont Blanc, the highest point of Europe, 15,782 feet high, is a dome of snow absolutely unbroken by rock of any shape or kind. It is large enough to accommodate three or four parties of climbers at a time, of not more than four on each rope. When M. Eiffel made his celebrated sounding of its depth, for the purpose of deciding how the summit observatory of M. Janssen was to be erected, he excavated a tunnel or trench 150 feet long and 50 feet deep without touching anything but snow and hard ice, so that the depth of the snow cap must be immense.

It will be recalled that Mont Blanc was climbed for the first time by Jacques Balmat and Dr. Paccard (who reached the summit perhaps an hour after Balmat) on August 8, 1786, ascending by the Montagne de la Côte, where they spent the night at the edge of the glacier, the Grand Plateau, and the Rocher Rouge. The next year it is a tradition that Balmat again ascended it on July 5, with two Chamoniards, Cachat and Tournier. But whether that be fact or not, on August 1, 2, and 3, 1787, Balmat conducted to the summit the well-known savant H. B. de Saussure, accompanied by his valet and eighteen guides, mostly laden with scientific apparatus. They reached the summit about 11 A.M. on August 3, and stayed there four hours while de Saussure carried out some of his contemplated experiments. But the whole party were grievously afflicted with mountain sickness. Indeed, very few of those who ascend Mont Blanc escape after passing the 12,000 feet level, as the writer, who only suffered from it once before in twenty-five years of climbing, can well testify. Next year, 1788, de Saussure more or less

completed his experiments at a lower level, in a hut on the Col du Géant, where he spent fifteen days.

In 1844 Prof. Bravais (so well known as the pioneer of our knowledge of space-lattices in crystals), with MM. Martins and Le Pileur, reached the summit, on August 17, and spent five hours in making observations.

In 1858 Prof. Tyndall ascended Mont Blanc and placed a thermometer with an iron stem four feet deep in the ice, in order to attempt to measure the winter cold. On August 21, 1859, he again made the ascent, accompanied by Prof. Frankland (afterwards Sir Edward), but they could not even find the thermometer. A second attempt failed through the thermometer being found broken. On this 1859 ascent the effects of solar radiation and of height on the rate of combustion were studied. Six candles were weighed at Chamonix, burnt for an hour in the Hotel de l'Union, and the loss of weight determined. The same candles were taken to the summit of Mont Blanc, and allowed to burn for an hour in a protective tent. The aspect of the flame surprised them, for it was "but the ghost of what it had been at Chamonix," being enlarged, pale, and feeble, suggesting diminished energy of combustion. Yet when the candles were weighed again after returning to Chamonix, it was found that the loss was almost exactly the same as before. The result was due to the greater mobility of the air at this great height, the oxygen molecules making up for their smaller numbers by their increased rapidity of movement.

Scientific observations were afterwards made on the summit by Prof. Hodgkinson on July 14, 1866, by Prof. Soret of Geneva on July 21, 1867, and on August 6, 1875, by M. Jules Violles of Grenoble, the last mentioned finding the temperature of the sun's rays to be 4° C. higher at the summit than at the foot of the Bossons glacier.

The ice movements at the summit were thus early recognised by Prof. Tyndall, whose thermometer must have moved some considerable distance. It reminds one of a statement by Capt. Sherwill, who, with Dr. E. Clarke, climbed the mountain in 1825, that Napoleon ordered a cross to be erected on Mont Blanc, and his command was carried out by Jean Marie Coutet. But the cross only remained erect for four hours, and in four days was thrown down and had entirely disappeared.

M. Joseph Vallot made his first ascent of Mont Blanc in 1880, purely as a climber. But in 1886 he returned to Chamonix, and made his first scientific expedition to the summit. The next year, 1887, he made another expedition and stayed three days on the summit, under a simple canvas tent, a feat of great hardihood which would have become tragic if the weather had changed from the fine spell. He obtained most valuable scientific results on this occasion, and decided to endeavour to continue them another summer in some more efficient protective building. In 1890, with the aid of more than a hundred guides who offered assistance, and a very small financial contribution from the Commune, he constructed the first observatory on the highest rock, which appeared to his judgment to offer

a good foundation for a durable edifice. It was a little flat rock, almost on the level of the snow, which goes down very steeply on the Italian (Courmayeur) side, in the little Col between the present refuge hut and the Grand Bosse du Dromadaire. The observatory proved immediately useful for experiments, and was enlarged twice, in the succeeding summers of 1891 and 1892. It was at a height of about 13,500 feet, measured about 16 by 10 feet, and was about 10 feet in height. It was divided into two portions, one for observers and the instruments, and the other as a refuge for climbers. Shortly afterwards, the climbing portion became such a nuisance to the observers that M. Vallot, at his entire expense, constructed the present separate refuge hut on the Rocher des Bosses at an altitude of 14,312 feet.

Unfortunately the little flat rock on which the observatory was built proved not to be the ideal spot which it was hoped it would be; the snow-field mounted up to it little by little, and ended by enveloping the little wooden structure up to the roof, rendering it unsanitary and almost uninhabitable. M. Vallot, however, was not discouraged, but, again entirely at his own expense, had a suitable foundation blasted in a part of the Rocher des Bosses, near to the refuge hut, and re-erected his observatory there, the work lasting forty-five days of the summer of 1898. The new building, constructed on a rock with a good escarpment, could not possibly be buried in the snow, and after twenty-seven years still defies the terrible tempests which break so suddenly and so often over this mountain. Each year it has afforded to scientists who desired to use it, after arranging with M. Vallot, a safe and relatively, remembering the position, most comfortable shelter in which to conduct their experiments.

Prof. P. J. C. Janssen, of Paris, the well-known astronomer, made an expedition to the Vallot observatory in 1890, and while there conceived the project of establishing an observatory of his own on the snow of the summit itself, in spite of the advice of M. Vallot, who tried to make him see that it is impossible to construct anything of stability on a glacier. M. Vallot says in a letter to the writer: "Janssen était un grand astronome, mais il ne connaissait les glaciers, et il a eu tort de ne pas vouloir écouter ceux qui les connaissaient. Il a voulu lutter contre le glacier, contre la nature; ce n'était pas possible, et il a eu un échec retentissant." At the request of M. Eiffel, M. Vallot lodged in his observatory the engineers and workmen sent by M. Janssen, and the observatory on the summit was constructed in 1893. A large telescope with 30-cm. objective was installed; but it was never possible to use this beautiful instrument on account of the instability of the glacier base. The meteorograph, constructed to work automatically, became frozen and entirely stopped in a few days. Hence, the observers had to be content with making studies in physics and astronomical physics, analogous to those which had been carried on continuously in the Vallot observatory. An expenditure of no less than 300,000 francs (then 12,000*l.*) had been incurred, furnished by public-spirited and scientific subscribers, to obtain very slight results.

Almost as soon as it was constructed, the summit observatory commenced to sink in the snow, which began to hold it as in a cup. The building was of two

storeys and about 23 feet high, and the roof formed a kind of outlook-platform, approached by a spiral stairway in a little tower. In 1900 the platform had sunk to the level of the snow of the summit, and to prevent the building being engulfed altogether, the snow around it had to be excavated away each year, in order that the upper storey might be used. But this labour soon became too considerable, and was given up in 1906. The snow then mounted over the roof, and in 1908 had covered it for a depth of more than a yard, leaving only just visible the top of the tower.

M. Janssen died in 1907, and as some funds remained a committee of management was formed, and M. Vallot was made director. In 1908 a delegation met on the summit, and certified that the observatory was buried, deformed, and breaking up. It was decided to abandon it, and the instruments were brought down. At the suggestion of M. Vallot the salvage of the debris was decided on, and in 1909 it was dug out and transported, more or less piecemeal, to the Col des Bosses, near to the spot where M. Vallot had erected his first observatory, where it is being gradually used for firewood for the Vallot observatory and hut. The observers sent by the Committee were accommodated by M. Vallot in his observatory, which appears to be now well off for fuel, formerly a very grave difficulty.

When the present writer reached the Col des Bosses on August 9, 1923, the first thing that attracted his attention was the remains of the Janssen observatory, lying clearly marked on the snowfield. A few further particulars were afforded him by M. Paul Cupeln, guide chef of Chamonix. According to the latter the summit observatory, just before being dug up, had begun to work its way out towards the Chamonix side of the mountain; its transport had been a very difficult matter, the whole of the parts being entirely carried 2300 feet of descent on the backs of porters and with the help of ropes fastened to posts driven into the steep snow slope.

The Committee was very unwilling to abandon the summit, and suggested to M. Vallot that he should utilise part of the debris to construct a small light laboratory on the summit, capable of being brought to the surface each year. M. Vallot consented, but with much misgiving. He had the little hut erected, but warned the Committee that it would not be safe against thunderstorms. The next year M. Vallot's people were able to relieve it from the submerging snow, but unfortunately his warning was but too soon verified, for an expedition which had imprudently stayed in the laboratory too long were caught in a violent thunderstorm and a member of the party was killed by lightning in the hut. The next year, 1912, no workmen could be found willing to dig out the laboratory, which was deeply submerged in snow. In 1913 it had entirely disappeared, and soundings and borings made to locate it failed to find any trace of it. Doubtless, some day, this second summit observatory will work its way out to the Chamonix side, towards which the ice movement appears to be especially directed, and remind the world of its fugitive, useful existence. M. Vallot's predictions were thus once more remarkably verified.

The impression that appears to have been current, that observers spent the year in the Janssen laboratory, is, of course, quite wrong. It was only habitable for

the short summer season, from the middle of June to the middle of September, the usual climbing season. The observers prepared all their experiments in the valley, made the ascent and possibly stayed two or three days, and then descended. The Vallot observatory is visited every year by young science graduates sent out by the Société des Observatoires, and regular memoirs are printed and published. Indeed, there is usually a waiting list of young savants eager for places

in the observatory, which is remarkably comfortable considering the height. Fortunately it is likely that some members of M. Vallot's family will continue the good work, and it is only right that every credit should be given to the great and generous man, great in every sense of the word, who in 1920, at the age of sixty-six, made his thirty-fourth and last expedition to the summit of Mont Blanc, and has just passed away amid the deepest regret.

### Soaps and the Theory of Colloids.<sup>1</sup>

By Prof. J. W. MCBAIN, F.R.S.

THE subject of colloids has suffered from an excess of conflicting speculations in the absence of precise and definite experimental evidence. It is still found difficult to devise methods of experiment which will yield exact, and also unambiguous, results.

At the time when we began work in this field one of the chief recognised characteristics of colloids was their changeability and the dependence of their behaviour upon the vagaries of individual specimens. The object was thoroughly to study one typical colloid in order to supply the definite evidence required for testing or building up the theory of the subject. No general theory can be true which is incompatible with carefully established experimental evidence obtained with any one typical material.

Our chief experience is that the more carefully the colloid is studied the less colloidal it is found to be. Soap is a unique material for the investigation of colloidal phenomena, because it illustrates nearly all the behaviour found in other colloidal systems, and it is one of the few common reversible colloids which have a definite, simple, known chemical formula. Last and most important, all results with soap solutions are quantitatively reproducible, and, in the many cases where our results have been tested in other laboratories, the experimental data have always been confirmed. We have been able to find one precise relationship after another, so that the results are almost lifted out of the colloidal field. Nevertheless it remains true that soaps are typical colloids, and that the results are of general significance in determining the behaviour of colloids and their relationship to other states of matter.

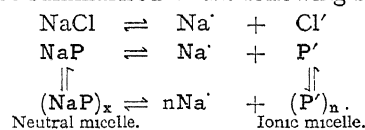
Soaps exhibit an apparently inexhaustible variety of behaviour, and few days pass without some new and interesting observation being made. A great deal of incidental information is obtained in the quest. For example, under certain conditions twice as much soap is required for a given amount of detergent action if the soap solution is allowed to stand for a day before use. Again, Miss Laing has carried out analyses which show that the substance which accumulates in the surface of soap solutions and of soap films is not free fatty acid but an acid sodium soap, a very slight excess of alkalinity in the soap solution converting it all to neutral sodium or potassium soap.

Soap is important as a type of a great class of substances known as colloidal electrolytes. It is essential to examine carefully the evidence obtained by a study of ordinary solutions of soap, since from it follows directly a proof of the micellar theory. The essence of

the micellar theory is that not the chemical molecules but aggregates of particles are the colloidal units.

It is necessary to show that hydrolysis, although always present to a slight extent, does not account for the major properties of the solutions. There are only traces of free fatty acid present, and there is but little free alkali, far less than in sodium carbonate; this has been shown by half a dozen independent quantitative methods. Hydrolysis is only of importance in dilute solutions. This is borne out by the fact that the hydrogen soap, cetyl sulphonic acid, has properties exactly parallel to ordinary soap in concentrated solution. Hence the major properties of a strong soap solution are due to the soap itself.

We have found that in dilute solution, soaps are ordinary crystalloids, just like common salt, and dissociate into sodium and potassium ions and simple fatty ions. Upon concentrating the solutions, however, the undissociated soap molecules aggregate to form large particles of neutral soap; that is, neutral micelles. Likewise the fatty ions unite in small groups to form a new type of particle—the ionic micelle—in which there is one free charge for each fatty ion. By changing the concentration or the temperature, all intermediate proportions of these constituents can be produced. This may be summarised in the following scheme:



The evidence for the foregoing conception is based upon a study of osmotic effects and of electrical conductivity. The osmotic effects as exemplified by the lowering of freezing point, of dew point, and of vapour pressure, and also the minimum pressure required for ultrafiltration, are in general half the values to be expected for the same concentrations of a typical salt such as sodium acetate. On the other hand, the conductivity of concentrated solutions is fully equal to that of sodium acetate. A large mass of data obtained chiefly in the laboratories of the University of Bristol has established both these truths.

If now the whole of the osmotic effect be taken as a measure of the sodium ions present, thus leaving no other crystalloidal constituent, rather less than half of the observed conductivity is accounted for. The other half of the conductivity must be due to colloidal constituents, and one of these constituents must have the same number of negative charges as there are positive ions: this is the ionic micelle. The undissociated

<sup>1</sup> Discourse delivered at the Royal Institution on Friday, March 20.

soap, too, must be in the form of aggregates or colloidal particles because of its negligible osmotic effect: this is the neutral micelle, and of the two it is the more important.

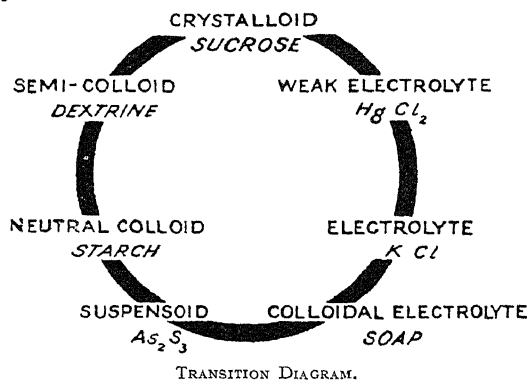
Long ago Selmi and Nägeli emphasised that not the chemical molecules, but larger aggregates, were the colloidal units out of which all larger structures are made. Nägeli in 1858 coined the word "Micell" from *mica* (a crumb), in order to have a term with no presupposition of crystal or any other particular structure. Many years of study of starch convinced him that the micelles of which these granules are composed are essentially crystalline, and now the X-ray work of Debye and Scherrer and Sponsler has shown that this is correct for such colloids as gold sols and wood.

With soaps there is no direct evidence of crystalline structure of the individual micelle, but Nägeli would have approved of the name micelle for the ordered arrangements based upon conceptions of polarity which since 1912 have become fashionable. The particles of neutral micelle in soap are found to range from a few hundred to thousands of Ångström units in diameter depending upon the soap and the conditions. These neutral micelles may be visualised by borrowing and modifying a suggestion of S. E. Sheppard's (*NATURE*, 1921, March 17, p. 73). Each particle is like a pair of military hair brushes, in which the bristles represent the hydrocarbon chains of the molecules arranged parallel to each other in sheets, two such layers being put together hydrocarbon to hydrocarbon. The two backs of the brushes on the outside represent the hydrate layer and the un-ionised electric double layer. A general survey of the facts with regard to the electrical double layers (*J. Phys. Chem.*, 1924, 28, 706) has shown that only a minute fraction of such a surface can ionise—hence the name "neutral micelle." Such a micelle would owe its stability to its internal polar arrangement of the molecules and to the external heavy hydration of the sodium and carboxyl group. The explanation of the stability of colloidal particles should be extended to the discussion of suspensoid particles where it is usually ascribed to the free electrical charges. The present conception would explain the stability by the hydration or solvation conditioned by even an undissociated double layer and at its maximum in the neighbourhood of uncompensated electrical charges. The principle here involved is the commonplace that like dissolves like, and that a particle remains in solution when it is completely surrounded or coated with chemical groups similar to those of the solvent.

The ionic micelle is more novel and is essentially different. It may be visualised by borrowing and altering a suggestion put forward by Reyhler in 1914 for particles of soap, and more recently by N. K. Adam. It resembles a group of, say, less than a dozen eels tied together by the tails, and pointing outwards in all directions from the common centre. Each eel is a fatty ion with the charged carboxyl group outwards. These carboxyl groups also are probably hydrated. Such an ionic micelle cannot grow large because the electrostatic repulsion would increase as the square of the electrical charges. The diameter of the ionic micelle as measured is only a few score Ångström units. Many experiments on migration in an electric field have shown that the ionic and neutral micelles exist and move quite independently of each other.

The conceptions put forward are a quantitative interpretation of the constitution of soap solutions and are therefore open to many kinds of direct test. One of the most cogent has been filtration (or ultrafiltration) through such a membrane as cellophane, the familiar transparent sheets of cellulose used in wrapping chocolates and certain high grades of soap. Dense membranes may be obtained through which a soap solution passes unchanged when it is in such dilution that conductivity and osmotic effect show it to be crystalloidal; that is, consisting of simple molecules and ions. The same membranes hold back all the soap, allowing only water to pass through when the soap solution is sufficiently concentrated that, according to the argument already given, the soap is entirely in colloidal form, neutral and ionic micelles. Intermediate solutions can be tested for the amounts of crystalloidal and colloidal constituents. Further, membranes with pores of any size may be obtained the diameter of which can be measured by the pressure required to blow air through them when wet; with these it is possible to hold back the neutral micelle allowing the ionic micelle to pass through. It is evident that the membranes too have a micellar structure. Again, by using a reference substance such as a salt, it is possible to measure the hydration of the colloid which is held back by obtaining a filtrate which on occasion is twice as concentrated in reference substance as the original solution. In this way it is shown that the micelle contains about ten molecules of water for each equivalent of soap.

Throughout the foregoing discussion only solutions, that is, transparent fluids, have been mentioned. The place that these colloidal electrolytes play in the general classification of all the known varieties of solutions is shown in the following diagram, where each type merges by gradual transition into the next.



*States of matter exemplified by soaps and their solutions.*  
—All soaps under suitable conditions can occur in each of several crystalline forms, in two forms of liquid crystals or anisotropic liquids, and finally in certain cases the solutions previously described may set to form true transparent jellies. These true jellies are like gelatine jellies in that they are clear and elastic, and when not under strain they are isotropic; that is, dark between crossed nicols.

On the other hand, the anisotropic forms which occur in higher concentrations are not miscible with the isotropic solutions or jellies but constitute separate phases. These doubly refracting liquids are not elastic but plastic; that is, they do not quiver when shaken, small portions do not flow under the influence of gravity

but passively remain in any position or shape which is given to them. These anisotropic liquids likewise have been found to be colloidal electrolytes.

It is remarkable that, when an ordinary soap solution sets to a true transparent jelly, such properties as conductivity and osmotic effect are unaltered. It is evident that the same equilibria and the same particles exist in each. The jelly structure must be built up by the neutral micelles linking together by bonds of residual affinity (*Trans. Faraday Soc.*, 1924, 20, 22) to form larger structures without losing their individuality. This well explains the reversible transformation of true jellies to sols.

There are at least two crystalline forms of soap, lamellar crystals and curd fibres. Both give X-ray diagrams, whilst none of the other forms of soap solutions already described give radiograms. Figs. 1 and 2 illustrate the appearance of curd fibres under the ultra-

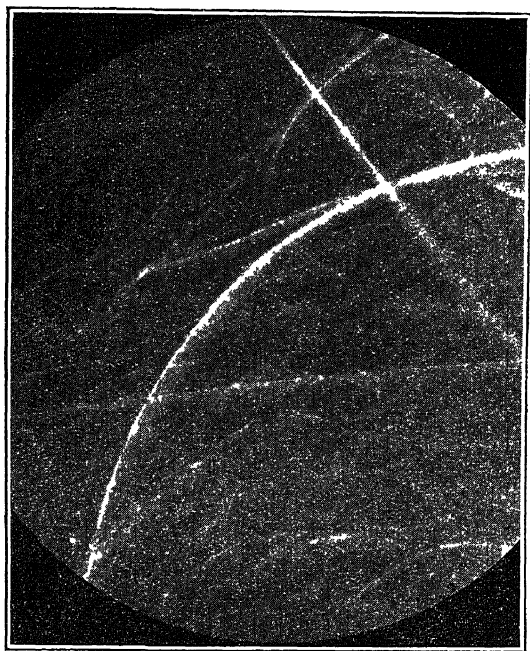


FIG. 1.—Ultramicroscopic appearance of curd fibres forming in 0.05N sodium behenate, with dark ground illumination.

microscope. Fig. 3, which is strikingly similar, is taken from von Weimarn and is a similar ultramicroscopic picture of barium sulphate suddenly precipitated from concentrated solution. In all cases the curd consists of these innumerable crystalline fibres enmeshing mother liquor.

Most of the substances of the type of soaps, such as dyes, etc., exhibit many of the forms here described. Probably every soap can be brought into each of these states under suitable conditions. They exhibit a great family likeness, and the conditions differ merely in degree. All these phases are found in the two-component system water: soap, and it has been demonstrated that the phase rule applies to their equilibrium with each other. No new phases appear when salts are added.

The equilibria are surprisingly subject to law and order. Simple numerical rules relate the action of various electrolytes with each other independent of the nature of the soap. Again, simple rules hold for all soaps and their mixtures. It follows that the behaviour

of the highly complicated mixtures of saponified oils and fats with various electrolytes met with in soap boiling can largely be treated on the simple basis of a three-component system. Thus by phase-rule models

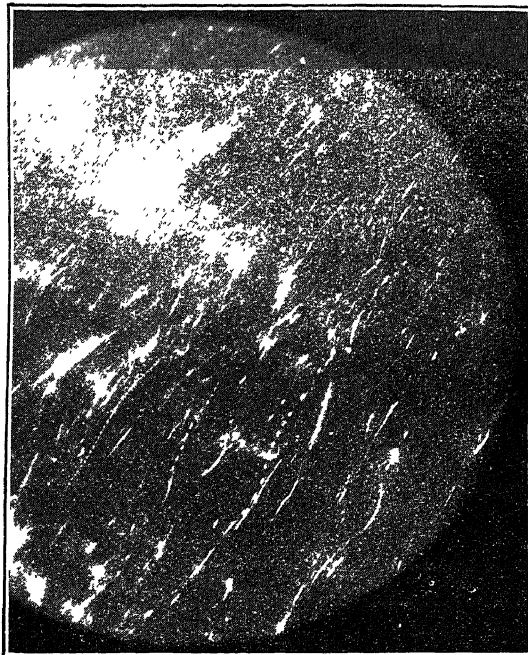


FIG. 2.—Ultramicroscopic appearance of curd fibres in 0.05N sodium behenate, with dark ground illumination.

it is possible to follow and predict quantitatively all the soap-boiling processes.

In conclusion, the hope and expectation may be expressed that, when various investigators have carried

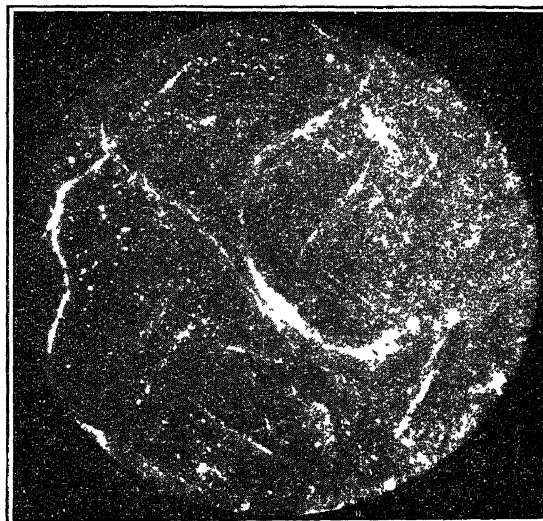


FIG. 3.—Ultramicroscopic appearance, according to von Weimarn, of gels of barium sulphate precipitated by sudden precipitation from concentrated solutions.

out sufficient careful and many-sided work with a number of definite typical materials like the soap which has been taken here as an illustration, the theory of colloids will ultimately become an exact science in which every statement will be demonstrable or subject to quantitative proof.

### The Southampton Meeting of the British Association.

THE British Association is about to issue the preliminary programme of its annual meeting, which will be held in Southampton on August 26-September 2 inclusive under the presidency of Dr. Horace Lamb, lately professor of mathematics in the University of Manchester. Southampton, which the Association has not visited since 1882, is one of the most interesting centres in the south of England for a meeting of this kind. Its University College will house several sections of the Association, and affords an example of a great educational institution in the making. The town itself is a focal point of overseas communications, and with this feature and the railway centenary of the present year in view, the programme gives special attention to various aspects of transport. This will form the subject of two days' discussion in the sections of economics and engineering jointly, while Sir Archibald Denny, as president of the engineering section, will give an address upon fifty years' evolution in naval architecture and marine engineering, and an evening lecture will be given by Mr. R. V. Southwell on aeronautical problems of the past and of the future.

Among other addresses, that to the physical section by its president, Dr. G. C. Simpson, Director of the Meteorological Office, will deal with "The New Idea in Meteorology." The address by Mr. A. R. Hinks, secretary of the Royal Geographical Society, as president of the geographical section, will be concerned with the science and art of map-making, a subject appropriate to the town which is the home of the Ordnance Survey. Prof. A. V. Hill, presiding over the physiological section, will speak on the physiological basis of athletic records, and this section and that of psychology will jointly discuss the acquisition of muscular skill. Mr. Tate Regan, in the chair of the zoology section, will deal with "Organic Evolution: Facts and Theories." Dr. W. W. Vaughan, headmaster of Rugby, will address the education section on "The Warp and the Woof in Education." The sectional presidents again include a lady, Miss Lynda Grier, principal of Lady Margaret Hall, Oxford, and a distinguished economist, who will take "The Meaning of Wages" as the subject of her address to the section of economics. The speakers and subjects for other presidential addresses are: Prof. C. H. Desch on the chemistry of solids; Prof. W. A. Parks, of Toronto, on the cultural aspects of geology; Dr. T. Ashby on

practical engineering in ancient Rome; Prof. C. Spearman on the mental law of diminishing returns; Prof. J. Lloyd Williams on the phaeophyceae and their problems; and Dr. J. B. Orr on the inorganic elements in animal nutrition. Sectional lectures already announced are by Mr. J. E. Barnard, on the observation of the infinitesimally small, and by Dr. D. H. Scott, on some points in the geological history of plants.

The many subjects already entered for discussion in the sections include the cost of farming and the marketing of agricultural produce; health in schools; the functional significance of size; the ignition of gases; the botanical geography of tidal lands; variations in gravitational force and direction; and recent investigations in the modern psychological field of vocational guidance.

The scientific interests of Southampton and its neighbourhood are exceptionally varied and attractive to visiting members, including the geographical and economic position of the town itself, the botanical study of the New Forest, the archæological features of Stonehenge, Winchester, and other sites, and the geological complexities both of the mainland and of the Isle of Wight. General excursions will be arranged to these and to other points, including a visit to the Channel Islands after the meeting, if there be sufficient demand; and particular scientific interests will be met by sectional excursions, such as the special visit of an anthropological party to Stonehenge, and inspections of the anti-gas school and diving-tender at Portsmouth and the aerodrome at Gosport which are being arranged on behalf of the physiological section.

The Association is maintaining its policy of attracting junior scientific workers to its meetings by making it possible for them to attend at a minimum cost, and as before has invited certain universities and colleges to nominate selected science students to "exhibitions" enabling them to participate in the meeting without expense to themselves.

The programme indicates that the Local Executive Committee for the meeting will make every endeavour to assist visiting members to obtain hotel, lodging, or hostel accommodation, and a form is provided on which they may indicate their wishes. A large attendance is hoped for, especially as the opportunity for reunion was denied to many members last year by the fact that the meeting was held in Canada.

### Obituary.

MR. W. W. ROUSE BALL.

WALTER WILLIAM ROUSE BALL was born in London on August 14, 1850, and was educated at University College School and afterwards at University College. He was primarily a mathematician, but his studies were not confined to one subject, for besides gaining the gold medal for mathematics in the M.A. examination of the University of London, he obtained a first-class in mental and moral science in the final honours examination for the B.A. degree in 1869. He commenced residence at Trinity College, Cambridge, in 1870 and graduated as second wrangler and first Smith's prizeman in 1874. He was called to the bar, and although he did not practise, he published a

"Student's Guide to the Bar," which ran through many editions. He was elected a fellow of Trinity College in 1875, and was a mathematical lecturer at the College from 1878 until 1905. He also held the post of tutor from 1893 until 1905, an office for which he was admirably qualified by his methodical habits, his sense of justice, and his wide sympathies.

With the exception of a few short papers Ball's published work on mathematics relates to the history of the subject, and appeared between the years 1888 and 1893. It stopped abruptly when he became tutor, and although afterwards he wrote again, he directed his attention to new subjects. But that he still retained his interest in mathematics was shown when

in 1922 he endowed the University of Cambridge with funds for establishing a special annual lecture in that subject.

In 1888 Ball published "A Short History of Mathematics," which reached a sixth edition in 1915. It contains, along with short biographies of the more prominent mathematicians, an interesting and well-written account of the development of the subject from the earliest times to the end of the nineteenth century. In 1889 the general history was followed by a "History of the Study of Mathematics at Cambridge," which, in addition to the information suggested by the title, contains an account of the general scheme of education at the University in medieval times and explains how this gave rise to the modern system of honours examinations with their curious name *Tripes*. He was especially interested in the works of Newton, and besides a paper on "Newton's Classification of Cubic Curves," printed in the Proceedings of the London Mathematical Society (vol. 22, 1891), he published in 1893 "An Essay on Newton's Principia." It is interesting to learn from the essay, along with more important information, that we may still repeat the story of Newton and the apple; for it appears to have been told by persons well acquainted with Newton, one of whom was vice-president of the Royal Society at the time when Newton himself was president. In 1892 appeared the "Mathematical Recreations and Problems," which is perhaps the best known of Ball's books, as it reached a tenth edition in 1922. The subject was a congenial one, for it was his hobby to collect information about all kinds of tricks, puzzles, and paradoxes, and a small book on "String Figures," which he published later, was another illustration of this habit of mind.

Ball's later publications deal mainly with the history of the University and Trinity College. They include "Cambridge Notes," "Cambridge Papers," a short monograph on Trinity College, an account of the King's Scholars and King's Hall, and a "History of the First Trinity Boat Club." He was also engaged for many years in editing, with the assistance of Mr. J. A. Venn, the five large volumes which contain the "Admissions to Trinity College, Cambridge."

The record of Ball's literary work is a lengthy one, but it only represents a part of his activity, for he was able to get through an immense amount of work. He took his full share (and something more) of administrative work both in his College and in the University, and for the last twenty years of his life he was one of the University representatives on the Town Council of Cambridge. His judgment was sound, and his advice was often sought and freely given. He was a warm friend, a delightful companion, and a courteous opponent, whose temper could not be ruffled. He had an especial sympathy with young people, which he retained to the last; for the same number of the *Cambridge Review* which contains his obituary notice contains also a full account of his speech at the centenary dinner of the First Trinity Boat Club. His full and active life came to an end on April 4.

WE regret to announce the following deaths:

Father A. L. Cortie, S. J., Director of Stoneyhurst College Observatory, and Director of the Solar Section of the British Astronomical Association from 1900 until 1910, on May 13, aged sixty-six.

Mr. H. Ling Roth, for many years keeper of the Bankfield Museum, Halifax, Yorkshire, on May 12, aged seventy-one.

### Current Topics and Events.

CONGRATULATIONS are due to Sir George Taubman Goldie, K.C.M.G., F.R.S. (elected 1902), who entered on his eightieth year on May 20. He is held in honour as the founder of Nigeria, the first Governor of which, Sir Frederick Lugard, appointed in 1914, was his friend and co-helper. Goldie made acquaintance with the wild Niger districts in 1877, when little more than thirty years of age, but earlier he had acquired a considerable knowledge of the African continent, which stood him in good stead when new possibilities loomed on the horizon. To add to the British Empire the tracts of the lower and middle Niger, already more or less penetrated by British traders, became Goldie's creative purpose. The introduction of ordered sway by chartered companies was an early conception, and some united efforts were made. In 1881 he sought to obtain a charter from the Imperial Government, but there were difficulties. In 1884 he succeeded in buying out the French traders, and the year 1886 saw the establishment of the Royal Niger Company, with Lord Aberdare as Governor and himself as Vice-Governor. The Germans, led by Prince Bismarck, were markedly antagonistic to all schemes. However, Goldie's efforts to obtain treaties with the numberless chiefs were eminently successful, and ultimately the British sphere was recognised. In 1900 the Company trans-

ferred its territories to the British Government, and by 1903 British sovereignty was acknowledged. Sir George was made a privy councillor in 1898. In 1905 he was elected president of the Royal Geographical Society, holding office for three years. He is an Hon. D.C.L. (Oxon.) and LL.D. (Camb.), honours conferred in 1897.

LORD BIRKENHEAD, in presenting the triennial gold medal of the Royal Asiatic Society to Prof. A. H. Sayce at a meeting of the Society held on May 12, paid an eloquent tribute to the value of the work on the archaeology of the East which Prof. Sayce has now pursued continuously ever since 1870. He referred to Prof. Sayce's edition of Herodotus, which, as he said, might well have engaged the life of most men, and pointed out that the great new linguistic studies in the East to which he passed on restlessly and insatiably, have proved of great intellectual consequence. Prof. Sayce and other scholars like him have rendered a service to Great Britain which is scarcely ever adequately measured, and never adequately rewarded, by their contemporaries. While the discoveries and sophistication of the West are not denied to the East, the reading of the incalculable minds of the East is a fundamentally more difficult task; but it has been

given to a few gifted Englishmen to understand more closely, with more sympathy, the mentality of the East than any other men in their day and in their generation. Lord Birkenhead referred in this connexion to Sir Richard Burton, and said that Prof. Sayce had achieved that learning mainly by his extraordinary gift for acquiring a mastery of Eastern languages and dialects, by an incredible degree of industry, and still more by a natural sympathy with the peoples, languages, and histories of ancient long-dead civilisations. Prof. Sayce's friends and colleagues will cordially unite in echoing Lord Birkenhead's closing words, in which he expressed a hope that Prof. Sayce, who has retained his physical strength and is now in the full maturity of his intellectual power, may enrich still further the field of human knowledge.

THE first Lister Memorial Lecture was delivered by Sir W. Watson Cheyne, Bart., F.R.S., on May 14, at the Royal College of Surgeons. This lecture forms part of the memorial to Lord Lister which was decided upon so long ago as October 1912. Part of the funds raised were devoted to placing a medallion in Westminster Abbey, part to the monument unveiled in Portland Place, London, in March 1924 (see *NATURE*, March 22, 1924, p. 430), and the remainder formed an International Lister Memorial Fund for the advancement of surgery. The Royal College of Surgeons of England became trustee for this latter fund, and it was resolved to award a bronze medal, with a sum of 500*l.*, every three years, in recognition of noteworthy contributions to surgery. Sir W. Watson Cheyne is the first recipient of the medal, and the award is particularly appropriate, apart from Sir William's scientific achievements, in that he was, with the late Sir Rickman Godlee, assistant to Lister in London. Sir William's lecture on the occasion of the presentation of the medal was a general account of Lister's aims and achievements, and the full and detailed story is promised in a forthcoming volume. Lister's early work at Glasgow is passed in review, leading up to the time when he learned of the work of Pasteur on fermentation and putrescence. The use which Lister made of this knowledge and the wonderful extensions of the work in surgery caused a revolution in surgical methods, for, as Sir William Cheyne says, "not only has his work led to the practical disappearance of septic diseases after operations, but it has enabled the surgeon to perform many operations which prolong life, restore movements, rectify deformities, and add to the usefulness and comfort of mankind." The complete lecture appears in the *Lancet* of May 16.

THE Tennessee Legislature recently enacted a law forbidding the exposition, in any educational institution supported by public funds, of theories holding that man is descended from the lower animals. Mr. J. T. Scopes, a high-school teacher, is to be prosecuted, presumably for contravening the law (the *Times* New York correspondent says "teaching of the theory of evolution," which is not quite the same thing), and Mr. W. J. Bryan has offered his services as associate counsel. The legal offence being, it appears, admitted,

the American Civil Liberties Union, with Judge Neal for the defence, will concentrate on the issue whether the State has the right to restrict theoretical inquiry (which also does not seem to be the point). The prosecution, however, we are told on the same authority, "stands ready to deal with the whole question of evolution." If this be admitted, the trial will at any rate add to the gaiety of nations. It has not yet been announced whether a rack, a thumb-screw, and the other means of compelling evidence in such cases have been provided by the State. Probably Mr. Bryan's scintillating eloquence will suffice.

IN distributing electrical energy for lighting and power purposes, it is necessary to have good electrical conductors to carry the current, and also to have good insulating materials to prevent leakage and accidental damage by short-circuits. During the last twenty years the progress made by the industry in improving insulating materials has not been in proportion to the great amount of work expended on the subject by research associations in almost every country. For insulating cables, paper and fibrous materials, which are impregnated by oils and waxes of various kinds, are usually employed. Their resistance varies enormously with the amount of moisture they contain, so that data obtained by measurement are practically useless unless their exact hygroscopic condition be accurately specified. Most experimenters also make the assumption that the resistance is independent of the direction of flow of the current, an assumption that can only be justified in few cases. At a meeting of the Institution of Electrical Engineers on April 23, K. G. Maxwell and A. Monkhouse read a paper on recent improvements of insulation. They devoted considerable attention to the discussion of the papers and press-boards, which are widely used in practice. Much was expected of asbestos, but its capacity for taking up moisture, and the fact that it often contains conducting fibres of magnetite, militate against its use. Vulcanised fibre is shown to be one of the poorest of the insulating materials, and it is curious that it is still so widely used. The use of machine building instead of hand building has considerably improved the quality of mica products. Perhaps the most satisfactory progress has been made in improving the best quality insulating varnishes. The authors pointed out that from the commercial point of view it would well pay modern firms to train specialised operatives. Many firms expend large sums of money in obtaining apparatus for testing insulation. For testing porcelain alone, one firm is stated to have spent 20,000*l.* on apparatus.

THE difficulties arising out of the administration and control of religious trusts in India, as exemplified in the dispute over the Sikh shrines in recent years, for the settlement of which legislation is now under consideration, are illustrated further by a case upon which judgment was given by the Judicial Committee of the Privy Council on an appeal for the High Court of Calcutta, which is reported in the

*Times* of April 28. A wealthy Hindu who died in 1846 set up a household god and provided for its continued worship. On the reconstruction of the house by his son many years later, two houses were built and a separate house was set up for all the household gods. When on the death of the son the estate was divided under a rule of the Court into three equal shares, a house was allotted to the eldest and the youngest sons, while the second son received provision to build a house. Under the scheme for the worship of the god, each son in turn conducted worship for a year; but after the idol had been taken to the second son's house on two occasions, objection was taken on the third occasion on the ground that it could not be moved from the dwelling of the household gods. Hence the litigation. The Judicial Committee decided that account must be taken of the personality of the idol, which is no mere chattel. It must therefore be represented by a guardian or a friend appointed by the Court, and further, as it is to be worshipped by both sexes, the interests of the daughters must be taken into account. A scheme of worship must therefore be framed by the High Court.

ON May 11 and 12, two lectures were delivered in the University of Oxford by Prof. R. Chambers, of Cornell University, on the results of his studies in micro-dissection. A description, illustrated by photographs, was given of the apparatus which has rendered possible the dissection of a single cell, and even the extraction of a single chromosome from a dividing nucleus. The same apparatus has also enabled Prof. Chambers to inject solutions of various salts into living cells, with curious results dependent in some measure on the strength of the solution. The "needles" employed for the manipulation are formed of glass tubing protracted into extreme fineness, and converted, if required, into pipettes by fracture of the drawn-out end. The objects to be dissected are contained in a hanging preparation on the lower surface of a cover-slip which forms the roof of a damp chamber with sides sufficiently patent to allow free play to the operating needles. Many interesting results have already followed from the use of the method, particularly with reference to the protoplasmic communication between cells without the intervention of the nervous system; the transmission of impulses controlling ciliary action; the exact points of adhesion between adjacent cells, and so on. The effects of injection upon isolated cells are striking, especially the trail of coagulated protoplasm left behind by an amoeba in endeavouring to roll away, so to speak, from the point where the puncture of a pipette has admitted a minimal quantity of calcium chloride. There is little doubt that the further employment of this valuable method will lead to results of still greater importance.

SOME further literature issued by the Industrial Institute (102 Belgrave Road, S.W.1) outlines the aims of that body in fuller detail. Industry consists in a threefold process, making, marketing, and financing. There is need for a central clearing house to co-ordinate data on these operations. Irregularities

in the demand for goods, associated with "trade-cycles," lead to wide variations in selling prices and unemployment. It appears that the national annual savings in Great Britain should suffice to employ the present annual increase in population. Authorities of the Treasury and the Bank of England have suggested that, in determining the flow of investment, consideration should be given to the problem of employment. The committee advising on the supply of credit under the Trade Facilities Act is understood to concentrate on the support of industries immediately productive of employment. It is thought that the representative character and experience of members of the Institute should be of special value in connexion with this suggestion, and it is proposed that a special committee should be set up to consider the whole problem on scientific lines and endeavour to bring about co-ordinated effort in industry.

THE Association to Aid Scientific Research by Women announces that it has just awarded the Ellen Richards Research Grant of 1000 dollars for the year 1925 to Miss Katherine MacFarland Chamberlain, of Detroit, Michigan, U.S.A. Eighteen theses were submitted in competition for the Research Prize, 8 of these from the United States, 7 from England, 2 from Wales, and 1 from South Africa; and while no one of these theses was, in the opinion of the experts who examined them, up to the standard set by the association for the Prize, the paper submitted by Miss Chamberlain was of such a character that the judges were unanimously of the opinion that opportunity for further research should be given to her. Miss Chamberlain graduated from the University of Michigan in 1914, receiving the degree of Doctor of Science in 1924, and she is at present instructor in mathematics in the College of the City of Detroit. Her work for the Prize was on "The Fine Structure of Certain X-Ray Absorption Edges," and was carried out in the laboratories of the University of Michigan between August 1924 and January 1925. A preliminary report upon this investigation appeared in our issue of October 4, 1924, p. 500. The Prize is not to be awarded again until 1927.

SIR WILLIAM H. ELLIS has been elected president of the Institution of Civil Engineers, and will take up office on the first Tuesday in November.

THE DUKE OF YORK has graciously consented to accept the honorary presidency of the thirty-sixth Congress of the Royal Sanitary Institute to be held at Edinburgh on July 20-25, at which the Right Hon. Sir John Gilmour, Bart., Secretary for Scotland, will preside, and deliver the inaugural address. A Health Exhibition is being held in connexion with the Congress.

At the annual general meeting of Manchester Literary and Philosophical Society the following officers were elected:—*President*, Rev. A. L. Cortie, S.J.; *Vice-Presidents*, Prof. W. L. Bragg, Prof. H. B. Dixon, Mr. Francis Jones, Prof. T. H. Pear; *Secretaries*, Mr. John Allan, Dr. W. H. Lang; *Treasurer*, Mr.

R. H. Clayton; *Librarians*, Mr. C. L. Barnes, Dr. Wilfrid Robinson; *Curator*, Mr. W. W. Haldane Gee.

THE next International Congress of Entomology will meet this summer at Zürich on July 19-26, with the well-known Swiss entomologist Dr. A. von Schulthess as president. The gathering will be representative of all branches of biology interested in entomology pure or applied, and many institutes and societies of zoology, hygiene, tropical medicine, plant pathology, forestry, etc., are sending delegates. Further particulars can be obtained from the Zoological Museum, Tring, Herts, or from H. Kutter, Zolliker-Str. 76, Zürich 8.

MR. K. S. MURRAY, who has been for many years the managing director of the British Oxygen Co., has been elected to the chairmanship of that Company, which has been rendered vacant by the death of Mr. E. B. Ellice Clark. Mr. Murray will for the present continue also to discharge the duties of managing director. He joined the Company as assistant engineer in 1887, and since then has been intimately associated with the development of the oxygen industry, and the remarkable industrial applications of oxygen which have taken place since the commencement of the present century.

DR. F. A. F. C. WENT, professor of botany in the University of Utrecht, is giving at various universities in England a series of lectures under the auspices of the Anglo-Batavian Society. Went is well known for his work on the development of the Podostemaceæ and on the Triuridaceæ and Polygalaceæ. He is also an authority on tropical crops, such as cocoa and sugarcane, and on many physiological aspects of plants, e.g. the physiology of fungi and of the irritable movements of plants. His lecture in London will be given at the Imperial College of Science and Technology on Monday, May 25, the subject being "Modern Conceptions of Light Stimuli in Plants."

ACCORDING to *Science*, Dr. H. S. Jennings, professor of zoology in the Johns Hopkins University, Baltimore, is to receive the first Joseph Leidy Memorial Award of the Academy of Natural Science of Philadelphia "in appreciation of his researches upon the Protozoa and the Rotatoria, and in recognition of his broad knowledge and keen understanding of the significance of biological phenomena." The award was endowed by a fund created in 1923 which will provide a bronze medal and an honorarium every three years "for the best publication, exploration, discovery or research in the natural sciences."

THAT indefatigable Autolytus, the curator of the Hull Museums, has for many years been snapping up such old and unconsidered vehicles as fell in his way, from bone-shakers to hansom-cabs, and storing them in any corner he could find. Hull's exhibit at Wembley last year and the emptiness of an old Corn Exchange, gave him an opportunity seized with his usual acumen and energy. "A Commercial Museum for Hull" was a good slogan, and the business firms responded admirably with exhibits and cases. But

there was still space to spare, and what more suitable to fill it than the shandrydands, for "the success of a commercial community depends largely on its means of transport." So the whole was fittingly opened on April 16 by Brigadier-General Sir Henry Maybury, of the Ministry of Transport, and Mr. T. Sheppard added another item to his collection of museums.

THE Rockefeller Medical Fellowships for the academic year 1925-26 will shortly be awarded by the Medical Research Council, and applications should be lodged with the Council not later than June 10. These Fellowships are provided from a fund with which the Medical Research Council has been entrusted by the Rockefeller Foundation. Fellowships are awarded by the Council, in accordance with the desire of the Foundation, to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery, and are likely to profit by a period of work at a university or other chosen centre in the United States before taking up positions for higher teaching or research in the British Isles. A Fellowship will have the value of not less than 350*l.* a year for a single Fellow, with extra allowance for a married Fellow, payable monthly in advance. Travelling expenses and some other allowances will be made in addition. Full particulars and forms of application are obtainable from the Secretary, Medical Research Council, 15 York Buildings, Adelphi, London, W.C.2.

IN the notice of Mr. W. S. Jones's book, "Timbers: their Structure and Identification," which appeared in *NATURE*, April 25, p. 601, two corrections are necessary. The genera of conifers treated are 19 in number, and not 14 as stated. The writer of the notice regrets that in some unaccountable way he overlooked the mode of distinguishing the woods of *Populus* and *Salix*, which is given in p. 73 of the book, namely, that the medullary rays are homogeneous in the former and heterogeneous in the latter genus.

CATALOGUE No. 795 of "Sotheman's Price Current of Literature" has just been issued. It comprises Part VI. of this well-known serial publication, and is as interesting and valuable as former parts. It gives the titles and full bibliographical details of nearly 3000 works on geology, mineralogy, crystallography, physical geography, meteorology, and microscopy, and, in addition, of sets or long runs of scientific periodicals and proceedings of scientific societies. The present part is noteworthy in that it includes the libraries of the late Prof. T. G. Bonney and Prof. G. A. J. Cole, and many volumes formerly the property of the late Sir Archibald Geikie. The catalogue should certainly be obtained by readers of *NATURE* interested in the subjects dealt with.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Lecturers in applied mathematics, geology, and botany in the University of Durham (Durham Division)—The Head of the Department of Pure Science, South Road, Durham (May 28). A junior assistant (physical

chemist) in the Colloid Chemistry Laboratories of the British Cotton Industry Research Association—The Director, Shirley Institute, Didsbury, Manchester (May 28). A manager recorder of experimental work in breeding poultry for table use, at the South-Eastern Agricultural College, Wye, Kent—The Secretary, South-Eastern Agricultural College, Wye, Kent. A technical assistant at the Marine Aircraft Experimental Establishment, Felixstowe—Secretary, Air Ministry, Adastral House, Kingsway, W.C.2 Inspectors of agriculture under the Sudan Government—Controller, London Office, Sudan Government, Wellington House, Buckingham Gate, S.W.1. A demonstrator in the department of inorganic and physical chemistry of Bedford College for Women—Secretary, Bedford College for Women, Regent's Park, N.W.1 (June 3). An assistant lecturer in mathematics and geography at Bristol University—The Registrar (June 3). A demonstrator in chemistry at the

London (R.F.H.) School of Medicine for Women, Hunter Street, W.C.1—The Warden and Secretary (June 6). A woman lecturer in education, in the Department of Education, Bristol University—The Registrar (June 8). An assistant lecturer in the physics department, Leeds University—The Registrar (June 15). A mistress for botany and physics at the County School for Girls, Tunbridge Wells—Headmistress. Professor of organic chemistry in the University of the Witwatersrand, Johannesburg—Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (July 15). A mistress to teach botany, chemistry, and mathematics at the North London Collegiate School, Sandall Road, N.W.5—The Head Mistress. Instructor Lieutenants in the Royal Navy—The Adviser on Education, Admiralty, Whitehall, S.W.1. A master for chemistry at Taunton School—The Headmaster.

### Our Astronomical Column.

THE 13-MONTH YEAR.—Calendar reform has moved a step forward in the reply just forwarded to the League of Nations by the representatives of British railways; in this they state that they are unanimously in favour of the adoption of a year of 13 months of 28 days each with one extra day (2 in leap years). This exact equality of the months would be a great convenience from the wage point of view. The objection is sometimes made that the division into quarters would be inconvenient: but our present "quarter days" are neither at the end of months nor equidistant from each other, so that the placing of them at the end of the first week of the fourth month, the second of the seventh, and so on, would be no worse than at present.

Most people who advocate the 13-month division of the year couple it with the plan of making every month begin with the same week-day, so that the days that stand outside the month would also be outside the week. However, the proposal to interfere with the regular sequence of week-days meets with strong opposition, and has little chance of adoption, but the 13-month reform would be quite useful even without this point. All the months of any year would still begin with the same week-day, but the day would change from one year to another.

COMETS.—A Harvard circular gives an elliptical orbit of Reid's Comet by Mr. Maxwell from observations extending from March 24 to April 7.

$T = 1925 \text{ July } 28.34 \text{ G.M.T. (new)}$   
 $\omega \quad 258^\circ 45' 54''$   
 $\Omega \quad 5 \quad 13 \quad 37 \quad \left. \vphantom{\begin{matrix} \omega \\ \Omega \end{matrix}} \right\} 1925.0$   
 $i \quad 25 \quad 36 \quad 12$   
 $e \quad 0.912875$   
 Period  $81.212 \text{ years.}$

Mr. G. Merton and Dr. A. C. D. Crommelin tested this period by including the observations of Mr. B. M. Peek, which extended to April 24. Their research gave a period of more than 12,000 years, so that the departure from a parabola seems to be much slighter than that announced by Mr. Maxwell. This comet is now too low down for English observers, but will come north again at the end of the year.

Very diverse statements have been published as to the date of the next return of Faye's Comet.

*Popular Astronomy* gave the date as the autumn of 1924, nearly a year too early. Mr. F. R. Cripps has now investigated the perturbations by Jupiter (B.A.A. Journ., vol. 35, No. 6), and finds Aug. 6 next as the date of perihelion. Major Levin and Mr. Gaddum give an ephemeris, which starts on May 15, but the distance from the earth is now so great that detection is unlikely for two or three months. Every effort should then be made to find the comet, as it has not been seen since 1910. No accurate ephemeris was prepared in 1918, astronomy being short-handed owing to the War.

THE VELOCITY OF LIGHT FROM THE STARS.—It has been pointed out by Prof. La Rosa that if the velocity of a distant star compounds with that of light, the observed intensity depends upon the acceleration of the radial motion. When there is acceleration towards the observer, light which is emitted at any moment will tend to catch up with that emitted at a previous instant. Thus the flux of light into an observer's eye will be greater than when the acceleration is zero and still greater than when it is negative. The effect will increase with the distance of the star. In the *C.R. Acad. Sci.*, Paris, March 2, M. Salet points out that de Sitter has concluded that no such compounding takes place, on the ground that the motion observed visually or spectroscopically in double stars is a regular Newtonian one. These stars, however, are not very distant, and it seems possible that, though the velocity of the source may not compound fully with that of light, the latter may be altered to a small extent. This might produce an effect in the case of very distant stars, only the brightness of which can be observed. The brightness of Algol does not vary by 0.1 mag. in the interval between successive minima, although the radial velocity varies continuously. The conclusion is that the velocity of the emitted light is not changed by more than 1/200 of the velocity of the star. There are stars of the same type which are much fainter, and it is probable that their distances are much greater, while their radial velocities are of the same order as that of Algol; it thus becomes possible to arrive at a much closer limit for the effect, which can be regarded as negligible even for the most distant of these stars.

## Research Items.

**STENCIL IN FIJI.**—Mr. Henry Balfour offers an attractive suggestion as to the origin of the art of stencil in Fiji in vol. 54, Part 2, of the *Journal of the Royal Anthropological Institute*. In patterning the borders of bark cloth the Fijian woman used a strip of banana leaf in which a pattern had been cut to make a stencil. Stencil is very rare among primitive peoples, and certainly does not occur elsewhere in the South Pacific. It was not introduced into Fiji by immigrants, nor is it probable that it was a heritage from the Melanesian stock, otherwise it would be found among other members of that stock. It must therefore be an indigenous development. If so, the idea of using perforated leaves may have been suggested by leaves naturally perforated by the larvæ of an insect. Bamboo leaves collected in the Naga Hills, which have been thus perforated before unfolding, exhibit resemblances to some of the Fijian patterns. These are always displayed transversely and never along the leaf, in exactly the same way as the perforation due to insect action. If correct, this explanation points to independent invention of the art of stencil in the Pacific and in Asia and Europe.

**THE PERUVIAN QUIPUS.**—Baron Nordenskiöld in a further instalment of his studies of South American Ethnography (*Comparative Ethnographical Studies*, 6, Pt. I., Göteborg, Elanders Boktryckeri Aktiebolag) describes a number of ancient Peruvian quipus and discusses their meaning and purpose. The quipus always consist of a main cord to which are attached a number of cords, usually arranged in groups and hanging down like a fringe. To these are usually attached subsidiary cords, with sometimes a further subsidiary set. A large number of knots occur on the hanging cords but not on the main cord. These knots are single or "long," i.e. the cord has been passed two, three, four, or more times up to nine through the loop. These knots indicate numbers in a decimal system, and comparative study points to the number 7 as playing an important part, although it had previously been held that the number 7 was seldom or never regarded as lucky or unlucky in the New World as it was in the Old World. In the early literature relating to Peru the quipus are stated to have been used for population statistics, accounts, and even memoranda of historical dates; but the fact that all that have been preserved have come from graves in association with so-called Inca pottery precludes them from having served as a record connected with the living. They must have some magical purpose connected with the dead. The subject will be considered further and in more detail in a second part of the volume to be issued later.

**SKILL IN RELATION TO PRODUCTION.**—In the presidential address to the Société des Ingénieurs Civils de France (British Section), February 18 last, Mr. L. A. Legros took as his subject "Skill in Relation to Production." He traces the evolution of some industrial processes during the past century, showing the changes which have taken place, involving the gradual displacement of skill from the actual manufacturing processes to the repairing processes. To work a machine may demand no skill, but to diagnose where a machine is wrong and to put it right demands skill of a high order; a good example of this type of skill is the marine engineer. Mr. Legros then discusses the attitude taken up by the trades unions, particularly in the so-called ca-canny methods characteristic of some trades at the present time. He deals sympathetically with the workers' point of view,

but shows where it breaks down, and is very critical of the attempt to bring down the rate of work to that of the poorest worker. The problem of monotony is touched upon, and Mr. Legros does not make the mistake of looking upon it as merely a question of repetition of movement. A very interesting section is devoted to the nervousness characteristic of the very highly skilled worker, a mental factor which has too frequently been overlooked both by the employer and the less skilled worker; realisation of temperamental peculiarities would guide those responsible into alleviating the conditions of their workers. He makes a plea for the education of most boys in manual skill so that those who govern should not be looked upon as ignorant by those who work. The address is very valuable and should be read and considered by all employers, intelligent workers and educationists.

**VACCINATION OF CATTLE AGAINST BOVINE INFECTIOUS ABORTION.**—Attempts to protect cattle against Bang's infectious abortion by the use of vaccines consisting of dead cultures of the causative micro-organism (*B. abortus*) have been unsuccessful. L. Forest Huddleson has therefore (Technical Bull. No. 65, Agricultural Experiment Station, Michigan Agricultural College) experimented with a living, highly antigenic, but non-virulent strain of *B. abortus*, with the view of using it as a protective vaccine. Several herds were treated, some of the animals in each herd being kept as controls. The breeding efficiency in Herd I was 87.5 per cent. for the treated, and 33.3 per cent. for the untreated, animals; in Herd H, 100 per cent. for the treated, and 75 per cent. for the untreated, animals. The results so far are encouraging, but much more work is necessary before a definite conclusion can be established.

**GERMICIDAL ACTION OF ULTRA-VIOLET RAYS.**—Previous investigations have been interpreted as indicating that the long wave-length limit of germicidal action is in the region of 297  $\mu\mu$ . W. W. Coblentz and H. R. Fulton (Scientific Papers, No. 495, Department of Commerce, Bureau of Standards, Washington, 1924) find that germicidal action is produced by ultra-violet radiation throughout the spectral range from the very short wave-lengths (Schumann rays) to and including 365  $\mu\mu$ . The shortest rays have the most violent lethal action, which decreases in intensity with increase in wave-length. The lethal action of radiations of wave-lengths longer than 305  $\mu\mu$  was found to be very slow in comparison with those of less than 280  $\mu\mu$ , and ceased with wave-lengths above 365  $\mu\mu$ . The energy value of the most active germicidal radiations from the quartz-mercury arc (170-280  $\mu\mu$ ) required to kill a bacterium is very small, being of the order of  $19 \times 10^{-12}$  watt.

**REVERSED SYMMETRY IN SNAILS.**—A type of genetic behaviour which offers some interesting anomalies is exhibited by the cases of reversed symmetry in snails. It is known that many species and genera are normally dextral, but occasionally produce sinistral individuals. Some genera are sinistral, and others still contain species of both kinds with only occasional reversal, while some species of *Achatinella* and *Partula* commonly produce both types freely. It is known that the reversal shows itself in the first cleavage of the egg, but the causes of reversal are unknown. A study of the inheritance of sinistrality in the normally dextral gastropod *Limnaea peregra* has been made by Capt. C. Diver, with Prof. A. E. Boycott and Miss

Sylvia Garstang (*Journ. Genetics*, vol. 15, No. 2), based on more than 600 broods (from hermaphroditic parents), and 53,000 young. The broods fell into six types: all dextral or sinistral, 3D:1S, 1D:1S, mostly S or mostly D; and all types can be obtained from D or S parents. In a closely reasoned presentation of the results, a hypothesis is reached which is too complicated to consider here, but it is assumed that the asymmetry of any individual is determined by the combined (or antagonistic) action of the chromosomes concerned, this action having a delayed effect. It is not considered that maternal inheritance will account for all the facts observed.

**CRYSTALLINE MICELLÆ IN THE PLANT CELL WALL.**—Taking up the micellar hypothesis, Nägeli applied it to starch and the cell wall so long ago as 1862. Steinbrinck, in the *Biol. Centralblatt*, vol. 45, pp. 1-19, 1925, shows how well this hypothesis helps to explain the data now accumulating with modern technique. For some time subsequent to Nägeli, the view was warmly supported that the optical anisotropy of the cell wall resulted from a state of strain. Nägeli's original observations made this unlikely, whilst Ambronn's recent observations (*Zeitschr. für Kolloidchem.*, 1916 and 1917) make it clear that in addition to the anisotropic effect due to layers of crystals with their long axes parallel, lying in a medium of markedly different refractive index, cellulose walls, and even nitrated cellulose in solvents such as celloidin, have doubly refractive properties depending upon the anisotropic qualities of the micellæ themselves. Steinbrinck now summarises the results of Röntgen ray investigation, with some photographs published for the first time, which lead to the conclusion that in hemp and ramie fibre the crystalline micellæ must be arranged symmetrically to the long axis of the fibre. In cotton wool, the diagrams obtained (by the Debye-Scherrer method) are in agreement with the assumption that the micellæ are symmetrically placed with reference to the direction of the spirals running with frequent reversals at an angle to the long axis of the hair. The fact that Katz obtains with the dry wall and with the wall after imbibition of water the same type of X-ray diagram supports Nägeli's original assumption that, in the main, the water is adsorbed into the spaces between the particles and not taken up into the micellæ. The German work summarised in this paper appears to be in very good general agreement with the work upon similar problems published in recent years by Dr. W. L. Balls and his colleagues (*NATURE*, June 21, 1924, p. 910).

**CONTROL OF DISEASE IN CROPS.**—The Natural History Survey of Illinois has been engaged for three years on the accumulation of a complete catalogue of the bacterial and fungus diseases present on the more important crop plants, together with their distribution throughout the State, the results to date being published by L. R. Tehon in Bull. 4, Vol. 15, Division of Natural History Survey. The diseases are grouped according to the crops that are subject to them, those of cereals, forage crops, fruit, vegetable and field crops and of a few commonly grown ornamental plants being dealt with in turn. In the text is given a brief description of the disease, a short summary of its history in Illinois, a statement of its distribution as now known, and a statement of the usual methods of control. This information is graphically illustrated by a comprehensive series of maps giving the distribution of each crop and of each disease described in the various counties of the State. In addition, the statistical figures are set forth in forty-two tables, many of which give

the estimated reduction in crop caused by the various diseases and the financial loss resulting therefrom, together with various observations on susceptibility and percentage of infection with different varieties in various districts. For the 44 crops investigated, 115 serious diseases are tabulated, with 50 of a less virulent type. For 16 of the serious diseases only, the average annual reduction in crop for wheat, oats, corn, apple, peach and pear is estimated as 56,398,929 bushels, the average annual loss being 44,452,053 dollars. These figures would doubtless be multiplied many times if it were possible to estimate the loss due to the remaining 49 serious diseases and the damage done by the 50 less serious ones, but, as it is, they are sufficiently large to impress on all cultivators the importance of adopting as widely as possible the approved methods of prevention and control advocated in the bulletin.

**JURASSIC ECHINODERMS OF SINAI.**—The late René Fourtau made many contributions to the palæontology of the echinoids of Egypt; at the time of his death in 1920 he had completed a memoir on the Jurassic echinoderms of Sinai, which has now been published by the Geological Survey of Egypt (Catal. Invertébrés foss. Égypte, Terrains jurass., 1, Echinodermes, 1924). The Jurassic deposits in North Sinai, from which the fossils were obtained, were discovered in 1913-14, and the Mollusca have already been described by H. Douvillé, who concluded that the horizons represented are Bajocian, Bathonian, Callovian, and Oxfordian. Fourtau finds evidence of the presence of deposits of later date, the Lusitanian. The echinoids are represented by 43 species belonging to the families Cidaridæ, Saleniidæ, Diademidæ, Echinidæ, Holactypidæ, Cassidulidæ, and Dysasteridæ. The crinoids belong to the genera *Apiocrinus*, *Millericrinus*, *Pentacrinus*, and *Cyclocrinus*. Altogether 52 species of echinoderms have been found, of which 19 appear to be peculiar to Sinai, while 27 are identified with species already known in the Jurassic deposits of western or southern Europe.

**PETROLEUM IN UGANDA.**—The occurrence and possibilities of development of petroleum are discussed in a report issued by the Uganda Geological Survey, by E. J. Wayland. The report is divided into five sections, embracing history, geology, petroleum, the Lake Albert field, and recommendations regarding exploration for oil. Four appendices are added, dealing with the outline geology of Uganda, the Kaise bone beds, the origin and significance of Lake Albert petroleum, and notes on Lake Albert itself. The critical oil geology of the region centres round Lake Albert, a depression forming part of the Great Rift Valley system. The floor of this depression is in crystalline rocks, and on these rest a great thickness of shallow water sediments divisible into two groups separated by an unconformity; the lower series are thought to be of Miocene age, while the upper have been shown palæontologically to represent late Pliocene or early Pleistocene deposition. The sedimentary rocks show a general tilt to the N.E., and locally have been folded into anticlines running parallel with the valley sides. Seepages of oil have been located in three places, at Mswa, Kibero and Kibuku, and the report recommends exploratory boring to test the petroleum possibilities of this Albertine depression, more particularly what is known as the Waki dome. The author states that "the presence of seepages . . . indicate that oil has been formed in enormous quantity in the Lake Albert depression; but not the slightest evidence has been found to show that either volcanic or tectonic processes have

played a part in its production." While the existence of seepages can never be, on general technical grounds, any criterion of magnitude of oil formation, the last part of that statement is indeed significant. The author's recommendations for exploration are carefully worded, though we fear that the "Rift Valley storehouses of petroleum," even if existent, are more likely to be found empty than full; we wish it were otherwise.

**SWEDISH METEOROLOGICAL RESEARCH.**—The publication of the data for 1917 of the observatory at Abisko in Swedish Lapland gives a complete series of observations from 1917 to 1922 (*Observations météorologiques à Abisko en 1917*, Upsala, 1924). The observatory has particular value as being one of the most northerly in the world, lying about two degrees north of the Arctic circle. The hourly records are given in full throughout the year, but there is no comparison with other years. Another valuable publication deals with the flow and temperature of Swedish rivers (*Hydrografiska mätningar i Sverige*), and is published as Part 5 of the year-book of the Statens Meteorologisk-Hydrografiska Anstalt.

**ATOMIC DISINTEGRATION.**—The *Physikalische Zeitschrift* of November 15, 1924, contains an account of work by Drs. H. Pettersson and G. Kirsch, of the Vienna Institut für Radiumforschung, on this subject. They describe their earlier methods, by means of which they claim to have observed atomic fragments with a range so low as 10 to 12 cm.; and they criticise the results of Bates and Rogers, which tend to show that radium-C gives off  $\alpha$ -particles with ranges of 9.3, 11.2 and 13.3 cm. in addition to the normal ones with a range of 7 cm., and would make the observation mentioned above impossible. Frau Dagmar Pettersson has investigated the problem and is of opinion that these long range  $\alpha$ -particles do not exist. The methods used are based on the author's explosion theory. The particles which fly off from the disintegrated atom in a direction at right angles to the original path of the  $\alpha$ -particle are observed, and by means of these it has been possible to measure the maximum range of H-particles from carbon, about 6 cm. Using a small ring of thin copper, activated on one side with radium-C, the  $\alpha$  rays from which fall on the substance to be investigated, it is possible to observe particles thrown off in the retrograde direction on to a zinc sulphide screen, with ranges so low as 11 mm.

**A HOT WIRE APPARATUS FOR MEASURING HIGH ALTITUDES.**—An apparatus described by MM. E. Huguenard, A. Mangan, and A. Planiol in the *C.R. Acad. Sci.*, Paris, March 16, employs two batteries, one of 16 and the other 18 volts, in series, the hot wire being connected between the positive pole of the first and the negative of the second, and an adjustable resistance R between the other two poles. The two negative poles are connected by a voltmeter, and R is adjusted so that the voltmeter reads zero when the pressure of the surrounding air is 760 mm. When the pressure is reduced, the temperature of the environment remaining constant, the convection from the hot wire diminishes, its temperature increases, the electrical balance is disturbed, the voltmeter deviates, and it is possible to determine experimentally the relation between deviation and pressure. If R is made of wire which has the same temperature coefficient as platinum, the readings may be rendered independent of the surrounding temperature. The sensitiveness of the apparatus to change in height increases as the pressure diminishes, and is about 1.8 times as great at about 14,000 metres altitude

as at the surface of the earth. With a barometer, on the other hand, the variation in reading for the same increase in height is about 4.4 times less at 14,000 metres than at the surface, so that the hot wire instrument at this altitude is eight times as sensitive as the barometer.

**RADIO-FIELD INTENSITIES.**—The Austin-Cohen formula used in radio-telegraphy gives as nearly as can be measured the radio-field intensity of the waves due to an antenna, after passing over salt water and during daylight, for distances up to about 5000 kilometres, provided that the frequency of the emitted waves lies between 60 and 1000 kilocycles. This corresponds to wave-lengths lying between 5000 and 300 metres. Several experimenters have stated that for greater distances and for higher or lower frequencies its inaccuracy is so large that it is practically useless. For long distance communication, frequencies so low as 15 kilocycles are sometimes used. In this case various observers have found that at a distance of 6000 kilometres the ratio of the observed to the calculated value of the radio-field intensity is about two to one. In order to get more trustworthy data, L. W. Austin has made some trans-Pacific measurements of radio-field intensity, and has published the results in the *Journal of the Washington Academy of Sciences* for April 4, 1925. Observations were made at San Diego, California, on the radio-field intensity of the signals emitted from Cavite and from Malabar, Java. The distance from Cavite to San Diego is 11,800 km. and the time difference is eight hours. This gives about two hours for observations in September without approaching the time of sunrise or sunset too closely. The distance from Malabar is 14,700 km., with a time difference of nine hours. On account of the weakness of the signals in comparison with atmospheric disturbances, a maximum inaccuracy of about 20 per cent. was possible. The final results show that when the observations were made in daylight, the observed value of the field strength of the signals from Cavite were about three times the value found from the Austin-Cohen formula, while the observed strength of the Malabar signals was about twice the calculated value. The frequency of the Cavite signals was 19.34 kilocycles (wave-length 15,500 m.), and of the Malabar signals 18.98 kilocycles.

**ATOMIC WEIGHT OF BORON.**—A recent redetermination of the atomic weight of boron has been carried out by H. V. A. Briscoe and P. L. Robinson and is described in the March issue of the *Journal of the Chemical Society*. The ratio  $\text{BCl}_3 : 3\text{Ag}$  was determined, the materials being very carefully purified. The final results gave an atomic weight of 10.82 for boron derived from Europe and Asia Minor and 10.84 for boron derived from North American deposits. The question is raised as to whether this difference is due to different proportions of isotopes in the two samples.

**DETECTING COMPLEX IONS.**—A method of determining the presence or absence of complex ions in solution is described by W. H. Patterson and J. Duckett in the March issue of the *Journal of the Chemical Society*. The miscibility temperature of two liquids (critical solution temperature) is elevated by the presence of impurities. This elevation is approximately a linear function of the concentration of the added salt. In the case of salt pairs, additive values for the elevation imply that neither complexes nor double molecules exist in the solution. Deviations from the separately calculated values measure the molecular complexity.

## Institut International de Chimie Solvay.

THE second of the triennial chemical conferences under the Ernest Solvay Trust was held in Brussels, on April 16-24, at the Fondation Universitaire, a palatial new club established since the War, under the presidency of "Sir Pope de Cambridge," who filled the office with distinction at the first conference. To quote *Le Soir*: "Chacun loue la clarté précise, la pondération, la pénétration et le tact parfait de sa présidence."

The members of the Scientific Committee present were: Mm. E. Briner (Geneva), O. Dony-Henault (Brussels), J. Duclaux (Paris), F. M. Jaeger (Groningen), A. Job (Paris), J. Perrin (Paris), F. Swarts (Ghent). In addition, the following attended by invitation: H. E. Armstrong (London), E. F. Armstrong (Warrington), G. Barger (Edinburgh), W. Barlow (London), A. Berthoud (Neuchâtel), J. Boeseken (Delft), W. L. Bragg (Manchester), C. S. Gibson (London), Sir W. B. Hardy (Cambridge), T. M. Lowry (Cambridge), Ch. Mauguin (Paris), Ch. Moureu (Paris), E. K. Rideal (Cambridge), H. Staudinger (Zürich), H. von Euler (Stockholm). The following professors in the University of Brussels were also present: G. Chavanne, J. Timmermans, H. Wuyts, E. Saerens, E. Herzen.

Twelve sittings were held, occupying six whole days, so the meeting was no mere joy-ride, the more as it took place under continental conditions of air and light and was a severe linguistic trial, English alternating with French in several tongues; indeed, even a little Swiss-German was introduced. That our self-sacrificing devotion was not unappreciated, is clear from a notice in *L'Indépendance Belge*: "Nous l'avons dit, les Conseils de Chimie, les conseils de Physique ne sont pas des congrès. Tout le temps dont disposent les savants qu'ils réunissent est consacré au travail. Généralement, on travaille encore au cours du déjeuner quotidien: la tâche n'est jamais interrompue."

The Council was received by His Majesty the King of the Belgians, at the Royal Palace, on the afternoon of Friday, April 17. Messrs. Heger and Lefebvre, Sir William Pope, Sir William Hardy, and Profs. Armstrong, Jaeger, Moureu, and Perrin had the honour of dining with the King and Queen and members of the Royal family at the Palace at Laeken on the Saturday evening. On both occasions all were much impressed by the cordiality and sincerity of our reception and by the obvious appreciation the King showed of the service the Guild of Science is rendering. The meeting was the subject of serious notice in the press, and we learnt from lady friends, who made purchases in the city, that the conference was talked of even in *lingerie* circles. Such notice in Great Britain is unthinkable. These matters are ordered differently abroad. The courtesy shown to their visitors by M. Heger and his colleagues and by Madame Solvay and other members of her family cannot be adequately acknowledged.

The following reports were presented and considered:

The Mechanism of Chemical Change, T. M. Lowry; Les Relations interatomiques médiatees dans les composés organiques, F. Swarts; L'Adsorption en relation avec la catalyse et les actions enzymiques, J. Duclaux; Les Réactions intermédiaires dans la catalyse, Andre Job; Lumière et réactions chimiques, Jean Perrin; On the Spreading of Fluids on Water and Solids and the Thickness of a Primary Film, W. B. Hardy; Structure des matières colloïdales à l'état solide, M. J. Duclaux; The X-ray Analysis of Crystal Structure and its Bearing on Chemical Constitution, W. L. Bragg; Organic Crystals, W. H. Bragg; The Configuration of the Carbon Atom and

the Geometrical Relations of this Configuration to those of other Atoms as evidenced in the Chemical and Crystallographic Structures of Organic Chemistry, W. Barlow; Recent Developments in the Theory of Catalytic Processes in Heterogeneous Reactions, E. K. Rideal; Catalysis at Solid Surfaces, E. F. Armstrong and T. P. Hilditch; Considérations sur l'autoxydation et les phénomènes catalytiques qui s'y rattachent, C. Moureu et C. Dufraisse; Catalysis and Oxidation, Henry E. Armstrong; General Views on Catalysis in Enzyme Reactions, H. v. Euler.

As to the outcome. The Conference was definitely an advance on the first. The subjects considered were more fundamental and of critical importance. It cannot be pretended, however, that the reports were adequately discussed. When published, probably at an early date, they will undoubtedly serve to stimulate a far more complete consideration of the issues raised. The discussions were not reported verbatim and will be known only in the form of brief summaries. Few of the reports were circulated in time and several were obviously insufficiently thought out. At the next Conference it should be made a condition that reports are all in the hands of those who are to participate in their discussion at least three, better six, months before the meeting. Instead of reproducing discussions, except in the briefest possible manner, to indicate who speaks and to what end, it may be better to allow each reporter to supplement his contribution and give a considered opinion, if not upon the proceedings as a whole, at least on the problems with which he is specially concerned. Remarks made almost casually at such meetings may be of profound significance.

M. Ernest Solvay undoubtedly did great service to science in endowing the foundation to which his name is now permanently attached. The organisation is destined to play an important part in the future development of physical science, by focussing attention, at suitable intervals, upon fundamental theoretical issues. There has been far too little serious discussion of this kind, and, as a consequence, chemistry, in particular, is encumbered with a mass of loose speculation by workers whose outlook is far too narrow for them to discuss with advantage the problems they affect to consider. We need to put an end to the present-day tendency, particularly obvious in chemical circles at the moment, to paraphrase in terms of new fashions, without in any way getting down to fact or making any real advance in treatment.

The great advantage of such international gatherings is that different mentalities are brought into contact and opportunity given to bring out the facts. The physical school to-day, unfortunately, has little regard for facts: its main office seems to be to distort them in the service of the fashion by which it is dominated. The most recently published text-books are witness of this tendency: a great volume of pseudo-mathematical sack is provided, but the bread of fact is scarce regarded, and there is not the faintest indication of the "proportionate judgment" being brought into play the use of which was so strongly insisted upon by Faraday—which he contended, moreover, should be the great outcome of devotion to scientific inquiry.

At the Conference, two main topics were under discussion—the nature of chemical change in its various forms, and molecular structure as revealed by X-ray and geometric analysis. No particular advance was made in dealing with the former, but the issues were presented probably more clearly and definitely than they have been hitherto: the view

of the French school was certainly broadened. The tendency is growing to recognise that the phenomena are of greater complexity than has been supposed, and even to hark back to Faraday's conceptions. It is an astounding fact and a great reproach to our science, that we are in no way agreed as to the precise mechanism underlying the simplest case of chemical change. We simply have no criteria. Unfortunately, we have wandered during forty years in the wilderness, wearing teutonic blinkers. At the root of our difficulty is the lack of philosophical outlook, due to narrowness of practical experience, insufficient knowledge of materials and processes, and undue specialisation. We need a Wagner to knit our scattered themes into rhythmic form: we need also to pay far more attention to fact.

The discussion of the structure of solids was probably the most important part of the proceedings. A great difference of opinion between chemist and physicist was apparent. The able account of the results of the X-ray analysis of crystals given by Prof. Bragg was much appreciated. It is clear that it is possible to determine the orientation of atomic centres in crystals, but it is in no way proved that the partitioning of the atoms among the molecules can be ascertained: Prof. Bragg was prepared to admit this. The volume occupied or influenced by the atom was also much discussed. Here again it

was agreed that the X-ray method, at present, affords no direct information and that only the distance between atomic centres can be fixed. Precision was given to this latter problem by Mr. Barlow, who gave an account of the way in which he has modified the original Barlow-Pope valency-volume hypothesis, by using a cell of unit-valency and forming models of atoms of higher valency by associating such unit-cells in the appropriate numbers. Mr. Barlow has constructed close-packed models of a considerable number of benzene derivatives which are in direct near agreement with crystallographic data: several of these were exhibited. The writer was able to point out how closely the properties of carbon were reproduced in the model of the carbon atom—a pyramid of four unit-dodecahedral cells—used by Mr. Barlow in constructing his models. Finally, the existence of atoms in the crystal—in common salt, for example,—as independent units was brought under discussion. Mr. Barlow exhibited a model of the molecule of potassium chloride, composed of two similar 13-faced cells; such *molecular* units may be close-packed in any numbers to give crystal units having all the geometric properties shown by potassium chloride. The writer expressed the opinion that it was impossible, from the chemist's point of view, on present evidence, to believe for one moment that the molecule lost its individuality in the crystal. H. E. A.

### Heavy-Oil Engines.

THE James Forrest Lecture for 1925 was delivered by Capt. H. Riall Sankey before the Institution of Civil Engineers on May 5, and dealt with some outstanding questions relating to large engines of the self-ignition type. The discussion was limited to engines working either on the two- or the four-stroke cycle, and compressing air to a temperature sufficient for the self-ignition of an injected fuel of not less than 0.82 specific gravity.

There are many difficulties in connexion with fuel-injection, and much research is still required before practical perfection is reached and the best method finally established. The two methods employed are air-injection and mechanical injection (also called solid injection). The former requires an air-compressor, and introduces oxygen with the oil, producing probably a small initial explosion together with an air-blast which causes turbulence and drives the oil into all parts of the combustion chamber. The expansion of the air cools the jet by some 100° F., which has to be allowed for by a higher initial pressure of the air in the cylinder. The air injector is able to impart greater energy to the atomised oil, to which is probably due the fact that a greater indicated mean effective pressure is possible with air than with mechanical injection, as has been found by Engineer-Commander Hawkes. The cooling effect of air-injection is especially noticeable at light loads, and may cause misfires and explosion troubles; mechanical injection is much freer from these troubles. It would appear that at present the economical results per I.H.P. are better with air-injection than with mechanical.

High temperatures and pressures occurring in heavy-oil-engine cylinders cause stresses which are difficult to meet. The parts principally affected are the cylinder head, the cylinder walls, and the piston. Cast steel is generally employed for the heads, since the same strength can be obtained with much thinner walls, and the temperature-stresses are thereby substantially reduced. In large cylinders with thick walls the temperature-stresses in the walls exceed the ring-stress due to the internal pressure. Various ways of strengthening the walls have been employed

and were mentioned by the lecturer. Some idea of the relative ring- and temperature-stresses may be obtained from the following figures given by Mr. A. D. Bruce for a 40-in. cylinder:

Thickness of Cylinder Wall.	Tension in lb. per sq. inch due to	
	Ring Stress	Temperature- Stress.
2 in.	5000	10,630
3.5 in.	2800	18,600

Temperature affects the design of pistons profoundly. Hopkinson has shown that a gas-engine piston 11.5 in. in diameter, without water or oil cooling, may have a temperature-stress of tension at the outside rim amounting to 7.5 tons per sq. inch. Hence, for larger diameters, cooling arrangements have to be adopted. Such arrangements—except in experimental engines—have not been successfully applied to pistons exceeding 33 in. in diameter.

A large mean effective pressure is desirable to reduce the weight of and the space occupied by the engine, and can be obtained by increasing the weight of oil injected per stroke if arrangements are made for reasonably perfect combustion. This requires an increase of oxygen packed into the compression space, and is known as supercharging. The method has been successfully worked to obtain higher powers with aeroplanes at high altitudes. It has been estimated that about 50 per cent more indicated power may be obtained by supercharging, but a deduction of about 10 per cent. must be made for the power required, leaving a net gain of 40 per cent. It cannot be said that supercharging has advanced very far at present, except in two-stroke engines, but it may be expected to produce great improvements in the future.

Among other matters dealt with by Capt. Riall

Sankey is the question of compounding. A group of American engineers, headed by Mr. Sperry (of gyro-scope fame), has been working on this subject for thirty years. Complete success with a small engine was reported in 1918, but Capt. Riall Sankey stated that he was not aware whether any large engine has yet been made or is under construction. In the small engine the mean effective pressure in each cylinder was 330 lb. per sq. inch, and the weight of the engine was about 0.1 that of an ordinary engine. The mechanical efficiency was said to be extremely high.

Capt. Riall Sankey, in concluding his lecture, urged the necessity for co-operation in research, and offered his appreciation of the work done at the Admiralty Research Laboratory and so freely communicated in papers read before the Institution of Naval Architects. The outstanding problem for the merchant marine is the production of a low-speed engine of much greater power than at present possible, and of lighter weight per B.H.P., but before this can be solved many subsidiary problems discussed in the lecture must be solved satisfactorily.

### Tertiary Floras.<sup>1</sup>

DR. BERRY continues to add to his vast series of researches into the Upper Cretaceous and Tertiary floras, a subject which has long been somewhat neglected in Great Britain. The question of the evolution of angiosperms is almost the greatest outstanding problem of palæobotany. We have practically no light upon it as yet; all that can be done is to record the history of the class as accurately as possible, and to this history Dr. Berry has long been the most indefatigable contributor.

The present memoir deals with a Middle and an Upper Eocene flora of North America, the former known as the Claiborne, the latter as the Jackson flora. The author had previously described the much richer Lower Eocene Wilcox flora. The Wilcox includes 350 known species, while from the Claiborne only 90, and from the Jackson 133 are recorded. These differences appear to be due rather to the conditions of deposition than to any poverty of vegetation in the later periods.

The Claiborne deposits extend at intervals from Georgia to south-western Texas; they are marine in origin, which helps to account for the scantiness of the remains. The plants include 1 fungus, 6 ferns, 5 conifers, 8 monocotyledons and 70 dicotyledons. The largest family is the Lauraceæ, of which 13 species are recorded, while the Leguminosæ are represented by 8 and the palms by 6. Some of the species (a cypress and two laurels) are represented in the form of petrified wood, of which sections are figured. The same is the case with some of the Jackson plants, including a beautiful specimen of palm-wood. Most of the commoner species occur

also in the underlying Wilcox and the succeeding Jackson formations. Many of the genera had already appeared in the Upper Cretaceous. Among the dicotyledons only three families out of 27 are gamopetalous. Two of the gamopetalous genera (*Diospyros* and *Apocynophyllum*) go back to the Upper Cretaceous. Dr. Berry thinks that the Gamopetaleæ were actually the last plants to appear, and that their wealth of species may only have been attained in post-glacial times. The comparative poverty of this group in trees and shrubs may, however, account for their rarity as fossils.

The Jackson flora has a similar geographical distribution to that of the Claiborne beds. The 133 species include 4 fungi, 1 liverwort (a *Marchantites*), 4 ferns, 1 *Equisetum*, 2 or 3 conifers, 15 monocotyledons, and 106 dicotyledons. There are 8 palms, 12 Leguminosæ, and no less than 16 Lauraceæ. Among the Fagaceæ, it is interesting to learn that the genus *Dryophyllum* is regarded as an "ancestral" stock, which gave rise to *Castanea*, *Quercus*, and other genera. One of the leaf-species is referred to the Proteaceous genus *Banksia*, now limited to Australia. Among the lime family there is a *Grewiopsis*, an ancient Upper Cretaceous genus, and also a *Tilia* of quite modern type.

These few notes can give little idea of the abundance of information in this extensive memoir. It is splendidly illustrated; most of the 65 plates portray the fossil specimens; a few show views of the localities, restorations, or analogous contemporary vegetation. One of the restored landscapes introduces animal life in the form of a *Zeuglodon*, an early and, to all appearance, ferocious whale. Dr. Berry is much to be congratulated on this fine memoir, his latest contribution to the subject to which his life has been devoted.

<sup>1</sup> The Middle and Upper Eocene Floras of South-eastern North America. By E. W. Berry. United States Geological Survey. Professional Paper No. 92. Pp. 206+65 plates. (Washington: Government Printing Office, 1924.)

### The Royal Society Conversazione.

ON May 13 the first of the two annual conversaziones of the Royal Society was held in the Society's rooms, and numerous interesting exhibits and pieces of apparatus were arranged for inspection by fellows and guests of the Society.

Among the exhibits from the British Museum (Natural History) were some oceanic angler fishes shown by Mr. C. Tate Regan (Department of Zoology). These fishes inhabit the middle depths of the ocean about 500 to 1500 metres below the surface. The males have become dwarfed and parasitic on the females, to which they become attached probably soon after they are hatched, when they are relatively numerous.

The Geological Department showed dinosaur bones from Tendaguru, Tanganyika Territory, a selection from the material sent home by Mr. W. E. Cutler of the British Museum Tanganyika Expedition. The largest and smallest femora (4 ft. 1 in. and

2 ft. 6 in. long) belonged to sauropodous dinosaurs which inhabited the estuarine waters of a great river running from west to east. The other femur (3 ft. 4 in. long) was from one of the armoured and terrestrial dinosaurs, such as *Omosaurus*, which is found in the Jurassic of England.

The National Institute for Medical Research had a demonstration showing a colour reaction for vitamin A (Dr. O. Rosenheim and Dr. J. C. Drummond). A brilliant ultramarine-blue colour reaction is given when arsenic chloride is added to a substance containing vitamin A. The reaction has been adopted for the colorimetric determination of the growth-promoting activity of medicinal cod-liver oils and butter.

The Cambridge Instrument Co., Ltd., showed, among other things, experiments with the Shakespear katharometer applied to the thermal-conductivity method of gas analysis. The instrument has small

capacity, a small time lag, and is very sensitive to certain gases having thermal conductivities differing from one another. It can be used for demonstrating the partial separation of two gases from a uniform mixture by introducing a temperature gradient within the gas, an effect first pointed out by Prof. S. Chapman and called by him "thermal diffusion"; for the measurement of the respiration of gas from a single insect, *e.g.* a fly; and provides an easy method of estimating a small quantity of carbon dioxide as carbonate in a mixture. The National Physical Laboratory exhibits included some photo-electric cells of different alkali metals used to detect a difference of colour in sources of light (Mr. T. H. Harrison). A rubidium and a sodium cell are connected in series, and the photo-electric currents balanced against each other when the two cells are exposed to the illumination of the same electric lamp. If the temperature of the lamp is raised the sodium cell becomes relatively more sensitive and vice versa. By this method lamps can be colour-matched to within  $1^{\circ}$  K. of the equivalent temperature and within 0.1 per cent. voltage. The Research Department, Woolwich, showed an apparatus for determining the flash velocity and pressure factors of ignitory detonators; the former by passing the hot gases through gaps—at specified distances apart—in separate electrical circuits whereby the circuits are completed, the instants of completion being registered by means of an Einthoven galvanometer; and the latter by means of a piezo-electric crystal. Prof. W. M. Thornton exhibited a miner's electric lamp which indicates and measures firedamp.

Mr. George H. Gabb showed a curious trumpet-shaped telescope bearing the name and date "Iacob Cvnigham 1661." The optical system is of the most elementary Galilean form, consisting of a bi-convex object glass, with a plano-convex eye lens, and gives a magnification of about 3 diameters at a focal length of 2 ft. It is focussed by two draw tubes covered with the characteristic marbled paper of the Charles II. period.

Demonstrations were given during the evening of a cinematograph film by Pathé Frères showing Brownian motion. The film was taken by the aid of a high power microscope, and showed the translatory, and in some cases the rotational, movements of particles in colloidal silver, smoke, etc.

Apparatus was also exhibited by the Thermal Syndicate, Ltd., the International Western Electric Co., and Messrs. Adam Hilger, Ltd.

### University and Educational Intelligence.

ABERDEEN.—The University Court proposes to proceed to the foundation of chairs in bacteriology and forestry.

The plans of a new building to accommodate the Department of Forestry, and to be erected in the Cruickshank Botanic Gardens, have been approved.

BELFAST.—At a special meeting of the Senate of the Queen's University held on May 13, it was resolved to grant the degrees of D.Sc. (*honoris causa*) to Prof. F. G. Donnan, professor of inorganic chemistry in University College, London, and to Prof. E. W. MacBride, professor of zoology in the Imperial College of Science, S. Kensington, both of whom are former students of Queen's College, Belfast.

BIRMINGHAM.—The University has arranged to hold receptions at Edgbaston for the meetings of the following Societies: Institute of Electrical Engineers (June 10), Medico-Psychological Society

(July 7), Iron and Steel Institute (September 10), Library Association (September 16).

CAMBRIDGE.—The Raymond Horton-Smith Prize has been awarded to Dr. M. B. R. Swann, Gonville and Caius College, for a thesis on "The Immediate Effect of X-Rays on the Functions of Certain Tissues and Organs." *Proxima accessit*, Dr. D. V. Pickering, Emmanuel College, whose thesis was on "Difficulties in the Dietetic Treatment of Diabetes."

It is proposed to confer the degree of Doctor of Laws, *honoris causa*, upon His Excellency the Right Honourable the Earl of Reading, Governor-General of India.

Prof. Nuttall, Magdalene College, Dr. H. Scott, Trinity College, and Mr. W. A. F. Balfour-Browne, Gonville and Caius College, are to be the representatives of the University at the international congress of entomology to be held at Zurich in July.

LONDON.—The Report of the Principal Officer of the University for the year 1924-25, read on Presentation Day (May 13), records no important development of the scientific side of the University's work. Candidates for first and higher degrees have reached record totals of 3063 and 357, and a grand total of 3420, of whom 2079 were internal and 1341 external. The roll of internal students comprises 9002 names, also a record. The total admissions by all channels amounted to 7603, as compared with 3852 in the last year before the War. Of these, 5542 came in through the ordinary Matriculation Examination, 360 as graduates of other universities, 1481 as holders of approved certificates, and 220 after examination under Statute 116. As there were 20,869 candidates for Matriculation and Registration, the high proportion of failures at the Matriculation Examination, which has recently provoked discussion, is evident. Grateful reference is made in the Report to the serious losses the University suffered in the deaths of Sir Sydney Russell-Wells, its representative in Parliament, Dr. R. M. Walsley, chairman of Convocation, and Prof. Arthur Dendy. Referring to the work of the Departmental Committee of the Board of Education, the Principal Officer says: "We may feel sure that the deliberations of the Committee, which has now been sitting for some months, will be guided by a single purpose, namely, our corporate welfare; and we may await with confidence its findings, not unmindful that in whatever form the body of our constitution be moulded, the spirit which gives life and growth remains always within ourselves alone." The list of benefactions received by the University during the year is somewhat meagre; but several of the colleges and medical schools have received generous gifts, notably the Middlesex Hospital Medical School, which has received 20,000*l.* from Mr. S. A. Courtauld for the endowment of a University chair of anatomy.

MAJOR K. W. BRAID, assistant in the Herbarium, Royal Botanic Gardens, Kew, since November 1923, has been appointed to the chair of agricultural botany in the West of Scotland Agricultural College, Glasgow.

NOTICE is given that applications for grants from the Chemical Society Research Fund must be made to the Assistant Secretary of the Society, Burlington House, Piccadilly, W.1, by June 1, on a special form to be supplied upon request.

APPLICATIONS for junior Beit Memorial Fellowships for Medical Research must be received not later than June 1, upon a prescribed form, by Sir James K. Fowler, Honorary Secretary, 35 Clarges Street, W.1. The fellowships are of the annual value of 350*l.* and tenable normally for 3 years.

## Early Science at Oxford.

May 26, 1685. Mr. Pulleyn is desired to take ye Chair.

A Letter from Mr. Maunders, dated Dunstar-Castle April 24 1685, was communicated by Mr. Crouch. With it there came some of ye shells of the purple fish from the shore near Dunstar; the Fish it self would have been sent, but it will not bear carriage hither. That matter, which gives the purple, is (as Mr. Maunders affirms) a little wat'ry substance in ye back of the fish, and not enough to make above six or seven letters. With these shells (some of which are ordered to be preserved in the Musæum, others to be sent ye Royall and Dublin Societies) there came specimens of 2 sorts of Laver (or *Lichen Marinus*) growing on the same shore; the one green and large, the other blackish and lesse; this last sort is that, which is pickled and brought to table, the former is not used in those parts. There came also a little piece of Lignum Fossile from Watchet.

Another Letter from ye same Person, dated Milton-Abby (in Dorsetshire) May 16, 1685 was read; it gave an account of what number of Persons were killed by cold in Dorsetshire on ye dreadfull 23 of December last.

The Society ordered their thanks to Mr. Maunders for these considerable communications.

A Letter from Mr. Aston dated May 21, 1685. was read; it contained a draught of ye Hony-combes mentioned in the Minutes of ye Royall Society and lately sent ye Society by Monsieur Villermont.

An account of a New Callesh invented at Dublin (the advantage of which is, that it may overturn without any danger to any Person in it) was read.

May 27, 1684. A Letter from Mr. Aston, dated May 15th, was read, with an Extract out of 2 manuscripts (supposed to be writ at least 300 years agoe;) concerning *Ignis Græcus*.

On this occasion Mr. Bernard affirmed, that there is an account of *Ignis Græcus* in an Arabick manuscript, in St. John's College Library in this Univrsity, and in Julius Africanus's Cesti cap: 45. Mr. Piggot said he was told, by one that makes fireworks, that Rockets made of Sulphur vive will burn under water. Dr. Plot shewed ye following Experiment: he held a live coal to ye lower part of an *hour-Glass* which immediatly stopped ye running of ye sand, this he repeated two, or three, times with ye like success.

Another Letter from Mr. Aston dated May 22, was read; it mentioned an Experiment of weighing air. Mr. Aston was desired by ye Society to give them an account of ye method usd in that Experiment.

A Paper of Mr. Flamsteeds was read, which gave an account of a *spot* which he had observed in ye *Sun*, about a month since.

The Answers of Mr. Proctor Clarke of Magdalen College and of Mr. King in Staffordshire, to some Queries about ye splitting of Trees in ye *frost*, were read. Dr. Plot said ye white grape vines in ye Physick Garden are dead, but not ye red, tho growing on ye same wall.

Mr. President observed, that severall vines which are split, are dead above ye place split.

Then Mr. Walker produced a modell of ye *Roof* of a Church, which may be built 70 foot wide, without any pillars in it, and a paper was read by him to prove, that such a roof would be strong enough for use.

Mr. Cooke, a gentleman near Newberry, and Mr. Packer M.B. a physician of Reading were elected. Mr. Todd M.A., fellow of University College and Mr. Benbrigg M.A. of the same College were proposed for election into the Philosophical Society.

## Societies and Academies.

LONDON.

Royal Society, May 14 —E. C. C. Baly and Elizabeth Semmens: The selective photochemical action of polarised light. I. The hydrolysis of starch. Starch grains in weak enzyme solution are hydrolysed under the influence of polarised light, whilst very little or no action takes place in ordinary light of the same intensity. In the case of potato and maize starch diastase was used, whilst in the case of wheat starch the natural enzyme sufficed. The slides were placed on microscope stages and illuminated from below so that the progress of the hydrolysis could be watched. Both daylight and artificial light were used with equal success.—R. B. Thomson and H. B. Sifton: Resin canals in the spruce (*Picea*). An anatomical and oecological study and its bearings on phylogeny. Anastomosis between different systems of resin-canals is rare in *Picea*. The bast has only horizontal canals, with bulbous expansions. Horizontal canals are strictly confined to the *secondary* rays. The canals, except in the wood, show cambial growth in size and thickness of wall. Formation of canals is not dependent on increased vigour or food-supply, and in secondary tissues it is always connected with injury or irritation of the cambium. The root, being very subject to injury, has a well-developed system of canals. In primary wood of the root the appearance of canals is preceded by that of solid strands of cellular tissue. Accumulation of repeated wound-stimuli explains the sporadic occurrence of canals in twigs of trees of species from which canals are otherwise absent. The whole evidence favours the hypothesis of a phylogenetic increase of sensitiveness to wound-stimuli among Coniferae.—H. G. Cannon: On the segmental excretory organs of certain freshwater ostracods. The "shell gland" of the freshwater ostracods, which has previously been described as the antennal gland, is of unknown function, but is in no way serially homologous with the true segmental excretory organs. These occur in both antennal and maxillary segments. The antennal gland (hitherto undescribed) consists of an end-sac with an intracellular duct leading to the exterior, consisting of three cells only. It attains its maximum development in the fourth larval stage, after which it loses connexion with the exterior and degenerates. The maxillary gland consists of an end-sac with an efferent intracellular duct consisting of four cells only. Its end-sac is a true coelomic sac. Its duct is formed by an ingrowth of ectodermal cells, that finally become overgrown by the surrounding ectoderm. The development of the "shell gland" has been partly described. The part previously considered as a typical end-sac, and therefore of mesodermal origin, arises from a group of ectodermal cells in outer layer of shell-fold.—E. G. T. Liddell and J. F. Fulton: Observations on ipsilateral contraction and "inhibitory" rhythm. Simultaneous mechanical and electrical records have been obtained (with string galvanometer and torsion-wire myograph of high frequency) of responses of quadriceps extensor muscle (cat) to various forms of reflex stimulation, before and shortly after section of the posterior root supply of the muscle. When the normal muscle is reflexly stimulated at 50 per sec. through the sciatic nerve of the same side, a small rapidly developed contraction ("ipsilateral") results, in which the rhythm of stimulus may be seen in both string and myograph. Crossed stimulation at 15 to 20 sec. before cutting the posterior roots also produces a response, but later, the rhythm tends to be obliterated through the

appearance of increasingly large numbers of "secondary" waves. After cutting, the secondary waves are more numerous from the start. Increase in mechanical tension increases amplitude of both primary and secondary waves. A single moderately strong break-shock inhibition during a crossed extension response causes, through suppression of secondary waves (repetitive asynchronous after-discharge), an enhancement of primary excitatory rhythm in both string and myograph. Repetitive inhibition, if weak, produces the same effect; if strong, it gives rise to a rhythm of its own rate in both records. This "inhibitory" rhythm during "complete" inhibition seems to be due to the small uninhabitable increment of ipsilateral contraction.—K. Furusawa: Muscular exercise, lactic acid, and the supply and utilisation of oxygen. Pt. X. The oxygen intake during exercise while breathing mixtures rich in oxygen. As was shown before, the maximum oxygen intake may be increased 50 per cent. by the breathing of a mixture rich in oxygen. This can be attributed only to an increased circulation rate of the blood.—J. S. Yeates: The nucleolus of *Tmesipteris Tannensis* Bernh. In *Tmesipteris* the maximum number of nucleoli in resting cells of the sporophyte is six. These are formed at telophase by aggregation of small bodies and are often visibly continuous with telophase chromosomes. In sister-telophase nuclei they frequently correspond in number, in size, and in position. During prophase and metaphase the nucleoli are connected with the ends of chromosomes, from which they finally become detached and pass irregularly towards the poles of the spindle. In some cases the full number of these nucleoli remains visible in the cytoplasm when a new generation of nucleoli has arisen in the daughter nuclei. In resting cells of the gametophyte the maximum number of nucleoli is three. The nucleolus is not an independent, self-perpetuating body, but seems to owe its origin to the chromosomes, and arises *de novo* in each cell-generation.

Physical Society, March 27.—H. W. Gilbert and P. E. Shaw: The electrical conditions arising at a liquid-gas interface. Many of the results may be explained in terms of the modern theory of orientation and polarisation at the liquid-gas interface, but there are other facts which do not appear to come within the scope of any established principles.—L. Hartshorn: A contact theory of dielectric absorption and power losses. A simple explanation is proposed of absorption residual charge and allied phenomena in solid dielectrics. In accordance with classical theory, the dielectric is assumed to possess a certain true capacity, defined by its dielectric constant, and a certain conductance, here considered as probably electrolytic in type. The so-called anomalous properties are considered to be due to the properties of the contact surfaces of the dielectric and its metal electrodes. These contact surfaces appear to offer great resistance to the passage of ions or electrons across them, so that when an E.M.F. is applied to a condenser there is an accumulation of charges at the surfaces. These charges form the absorbed and residual charges. The behaviour of each contact surface is such that it may be represented by a large capacity in parallel with a high resistance, and thus a capacity-resistance combination is suggested, which is equivalent to an actual condenser.

Linnean Society, April 2.—W. R. B. Oliver: Biogeographical relations of the New Zealand region. From a biological view-point the outstanding characteristics of the fauna and flora of the New Zealand region are the absence of mammals, the marked dis-

similarity of its plant and animal productions to those of Australia, and the presence of an element common to two or more of the southern land-masses. A large proportion of the plants and animals at present living in New Zealand are such as require continuous land connexion for their dispersal. Their presence demands that at some period in the past New Zealand was joined to the other land-mass of the globe. Most of these animals and plants are related to species now found in lands to the north. The so-called "Antarctic" element appears to be a mixture of several elements. Eliminating the genera and species of plants common to New Zealand and South America which may be explained by migration from the north overland and from the west overseas, there remains a residue which seems to demand a more direct land route between New Zealand and South America.—W. C. F. Newton: The cytology of the genus *Tulipa*. The basic number of chromosomes is twelve, but as a result of fragmentation one species has sixteen. Alteration in the relative size of the chromosomes may occur independently of fragmentation. Tetraploid and hexaploid varieties and species occur. The different kinds of tetrad found in *Tulipeæ* have their exact parallels in the *Acrididæ*, thus helping to emphasise the essential similarity of the meiotic phase in plants and animals.

## PARIS.

Academy of Sciences, April 13.—G. Ferrie and R. Jouast: The use of photo-electric cells for the observation and maintenance of astronomical pendulums. A mirror is attached to the pendulum and light from this falls on a photo-electric cell: the resulting current is amplified by three or four valves. Measurements are being taken to compare, with the highest possible precision, the results obtained by this method with that given by the ordinary electrical contact.—Jules Andrade: The general mechanism of synchronisation.—Gaston Julia: A type of quasi-analytical functions.—Oscar Zariski: The development of an algebroid function in a domain containing several critical points.—S. Ch. Bochner: The nearly periodic functions of Bohr.—Comas Sola: The Schain comet (1925a) found independently. A photograph taken on the night of March 23 has shown the new comet found on the preceding night by Schain.—Charles Nordmann and C. Le Morvan: The ballistic theory and stars with continuous variation. Some deductions from the ballistic hypothesis of La Rosa.—Louis Damblanc: An apparatus applicable to aviation motors for reducing the loss of power with altitude.—Jean Dubief: The variation of the viscosity of fluids as a function of the volume. The relation between the viscosity of a gas  $\mu$ , at a fixed temperature, compressed to a volume  $v$  is equal to that of a perfect gas multiplied by the factor  $v/(v-b)$ , where  $b$  is the co-volume of Van der Waals. The results calculated from this formula are in good agreement with the experimental figures of Philipps.—Jean Thibaud: The quantity of heat given off, in the form of the  $\gamma$  radiation, during radioactive disintegration. The energy emitted in the form of the  $\gamma$  radiation is never negligible: for radium B+C, it amounts to 16 per cent. of the total calorific effect.—Louis Jacques Simon: The viscosimetric neutralisation of the monoacids by alkalis. Comparison of the alkaline chlorate, bromate and nitrate. Measurements of viscosity in aqueous solution enable the course of the neutralisation of the acids to be closely followed. No relation between viscosity and isomorphism could be made out.—Volmar: The photolysis of the dibasic acids. In the cases of oxalic, malonic, succinic, and glutaric acids there was agree-

ment between the experimental facts and the law of photochemical equivalence.—P. Bugnon: Leaf homologies in the sweet violet: stamens and carpels. In the violet the stamens are homologous with the petals.—O. Munerati: Variations in the composition of the juice of a beetroot according to the state of disintegration of the tissue and the methods of expression. Two variables are studied, the state of disintegration before applying pressure, and the magnitude of the pressure applied. The variations observed are expressed in terms of the percentage of sugar in the expressed juice.—H. Lagatu and L. Maume. The linear relation between the successive quantities of phosphoric acid and nitrogen contained in the leaf of the well-nourished vine.—Émile F. Terroine and Mlle. S. Trautmann and R. Bonnet: The quantitative bio-energy law of the formation of carbohydrates at the expense of proteids and fats in plants. The transformation of proteids into carbohydrates in plants is accompanied by a loss of 35 per cent. of the metabolised energy; with fats there is a loss of 23 per cent.—E. Aubel and J. Salabartan: The mechanism of the production of hydrogen at the expense of glucose by the coli bacillus. Evidence is given in support of the view that the glucose is converted into equal molecules of pyruvic acid and hydrogen.—H. Labbé and F. Lavagna: The chemical composition of the normal and pathological crystalline lens. Determinations of water and various forms of combined nitrogen in a normal lens and one with cataract. In cataract there is a modification of the normal proteid content, a sensible disintegration of the albumen, and a large increase in the proportion of aminoacids and in the products of incomplete hydrolysis of the albumens. These characters point to the intense proteolysis which accompanies the evolution of cataracts.—C. Levaditi, S. Nicolau, and P. Poincloux. The etiological rôle of *Streptobacillus moniliformis* in acute septicæmic polymorphic erythema.

## CALCUTTA.

Asiatic Society of Bengal, March 4.—H. Bruce Hannah: Indian origins. The Pāncha-Janāh mentioned in the Rig-Veda were probably four concrete communities of Western Asia who had belonged to the invading forces defeated in Syria c. 1156 B.C., by Rāmāsēs III., and had afterwards plunged off eastwards, plus a *drūj*-folk picked up in or near Gāndhāra-land. The Dasyūs of Sapta-Sindhavāh were diffused representatives, east of the Indus, of the ancient and widespread Dahyūs of Central Asia.—Sri Ram Sharma: A forgotten hero of Marwar.—D. Majumder: Physical characteristics of the Hos of Kolhan. Anthropometric measurements of 200 Hos of different septs and localities are given.—Satyendra Ray: The earth's electric field and vertical potential gradient. The potential of the earth's electric field falls much more rapidly with height than would be expected with a radial field. The curve showing the variation of the potential gradient with height, as given by Schweidler and Kohlrausch, suggests an exponential curve. From theoretical considerations a formula is obtained which fits the curve and explains simultaneously the variation of the potential with pressure and the atmospheric "pollution."

## WASHINGTON, D.C.

National Academy of Sciences (Proc Vol. 11, No. 2, February).—E. H. Hall. Conditions of electric equilibrium at boundary surfaces: Volta effect. A theoretical development based on the theory of "free" and "associated" electrons in metals.—A. H. Compton and J. A. Bearden: The effect of a surrounding box on the spectrum of scattered X-rays.

A water-cooled molybdenum target X-ray tube and sulphur secondary radiator with no surrounding box were set up outside a window and the spectrum photographed. Modified lines were found in the spectrum predicted by Compton's theory.—R. A. Millikan and I. S. Bowen: The significance of the discovery of X-ray laws in the field of optics. Work on the spectra of stripped atoms of phosphorus (P V), sulphur (S VI.), and chlorine (Cl VII.) has completed the proof that Moseley's law and its corollary, the irregular doublet law, holds in optics. To account for the regular or relativity doublet law in optics requires a new hypothesis. The doublets of atomic hydrogen and ionised helium are attributed to a true relativity cause, but those of lithium and all heavier elements to a non-relativistic cause, perhaps of magnetic or electrostatic and magnetic origin, giving similar results.—Y. H. Woo. The Compton effect and tertiary X-radiation. The water-cooled molybdenum target X-ray tube was enclosed in a box lined with  $\frac{1}{16}$  in. lead sheet, and rock-salt, magnesium, aluminium, silicon, and sulphur were used as secondary radiators. Shifted lines were found in accordance with the predictions of Compton's theory, but there was no evidence of the tertiary radiation observed by Clark, Duane, and Stifler.—E. Condon. The age of the stars. The relativistic relation between energy and mass leads to a means, independent of atomic processes, of estimating the age of the stars.—W. J. Luyten: Notes on stellar statistics. III.: On the calculation of a mean absolute magnitude from apparent magnitudes, angular proper motions, and linear radial velocities.—E. B. Wilson and W. J. Luyten: (1) The frequency distribution on apparent magnitude of the non-Magellanic O-type stars. Among the O-type stars there is probably a fairly large dispersion in intrinsic brightness and a fairly large scattering through space. (2) The population of New York city and its environs. The ultimate population of New York city and its environs predicted by means of the Pearl-Reed curve would be 35 millions. Applying the same method to the population of the States including this area gives only about 22 millions. Hence one or both of the populations will probably soon enter upon a new cycle of growth. The Pearl-Reed method predicts "saturation" with a population but does not allow for the condition of additivity. It can give more probable results if modified constants are used.—J. W. Alexander: On the intersection invariants of a manifold.—P. Franklin: The rotating disc. Einstein's qualitative discussion indicates that the geometry on the disc cannot remain Euclidean; quantitative discussions by Lorentz and Eddington start from equations of transformation corresponding to a Euclidean rotation and end by computing contraction. An attempt is made at reconciling these opposed points of view.—G. A. Miller: Transitive groups involving direct products of lower degree.—A. C. Redfield and A. L. Hurd: The respiratory functions of the hæmocyanins. The blue colour of the blood of the squid and horse-shoe crab is due to "oxyhæmocyanin," but the hæmocyanin of the crab has much greater affinity for oxygen. This affinity is increased by carbon dioxide, whereas in the squid it is decreased, a fact which seems related to the mode of life.—T. M. Carpenter: Prolonged fasting as affecting the composition of steers' urine.—P. Heymans and W. J. Heymans: The torsion problem of curved beams.—E. M. East and A. J. Mangelsdorf: A new interpretation of the heredity behaviour of self-sterile plants. Self-sterility in *Nicotiana* is a Mendelian recessive in crosses between self-fertile and self-sterile species. Members of a self-sterility group are cross-fertile with members of other similar groups, but the class of the mother is never represented in the progeny.

## Official Publications Received.

Department of the Interior: United States Geological Survey. Forty-fifth Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior for the Fiscal Year ended June 30, 1924. Pp. ii+83+1 plate. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 750-G: Bauxite in Northeastern Nevada. By B. B. Burchard. Pp. ii+101-148. Bulletin 751-D: Geologic Structure of San Juan Canyon and Adjacent Country, Utah. By Hugh D. Miser. Pp. iv+115-155+plates 15-20. Bulletin 751-F: The Ekalaka Lignite Field, Southeastern Montana. By Clyde Max Bauer. Pp. iv+281-267+plates 30-34. Bulletin 751-G: Geology and Oil and Gas Prospects of part of Moffat County, Colorado, and Southern Sweetwater County, Wyoming. By Julian D. Sears. Pp. v+269-319+plates 35-37. 20 cents. Bulletin 753. Geology and Oil Resources of a part of Los Angeles and Ventura Counties, California. By William S. W. Kew. Pp. viii+202+17 plates. 50 cents. Bulletin 760-B: The Physical Features of Central Massachusetts. By William C. Alden. Pp. v+13-105+plates 6-22. Bulletin 761: Molybdenum Deposits; a short Review. By Frank L. Hess. Pp. iv+35+10 plates 15 cents. Bulletin 762: Geology and Ore Deposits of the Rochester District, Nevada. By Adolph Knopf. Pp. ix+78+4 plates. 15 cents. Bulletin 765: Geology of the Region around Lead, South Dakota, and its Bearing on the Homestake Ore Body. By Sidney Paige. Pp. iv+53+11 plates. 20 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Professional Paper 134: Upper Cretaceous and Lower Tertiary of the West. Part 1: The San Juan Basin, Colorado, and New Mexico, by John B. Reeside, Jr.; and Flora of the Animas Formation, by F. H. Knowlton. Pp. iv+117+19 plates. 40 cents. Professional Paper 135: The Composition of the River and Lake Waters of the United States. By Frank Wigglesworth Clarke. Pp. iv+199. 50 cents. (Washington: Government Printing Office.)

Publications of the United States Naval Observatory. Second Series, Vol. 10, Part 2, Appendix: Total Solar Eclipses of August 30, 1905, and June 8, 1918, with Aviators' Notes on the Eclipses of September 10, 1923. Pp. iii+B416+50 plates. (Washington: Government Printing Office.)

Review of Agricultural Operations in India, 1923-24. Pp. vii+152+8 plates. (Calcutta: Government of India Press.) 19 rupees; 2s. 9d.

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 7, No. 5: The Buffer Action of Soil. By J. Charlton. Pp. iii+101-121. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 12 annas; 1s.

Report of the Kodaikanal Observatory for the Year 1924. Pp. ii+4. (Madras: Government Press.) 6 annas.

Imperial Department of Agriculture for the West Indies. Sugar-Cane Experiments in the 1924-25 Season. Report on Experiments with varieties of Sugar-Cane conducted in Antigua, St. Kitts-Nevis and Montserrat in the Season 1923-24. Pp. ii+54. (Barbados) 1s.

The Indian Forest Records. Chemical Series, Vol. 11, Part 5. The Constituents of some Indian Essential Oils. Part 16: Note on the Reaction of  $\alpha$ - $\Delta^3$  Carene and other Terpenes in the presence of Catalysts. By Madayar Gopal Rao. Pp. ii+10+7 plates. (Calcutta: Government of India Central Publication Branch) 12 annas; 1s. 3d.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1923-24. Pp. iv+85. (Barbados) 6d.

Records of the Survey of India. Vol. 18 (Supplementary to General Report 1921-22): Annual Reports of Parties. Prepared under the Direction of Col. C. H. D. Ryder. Pp. iv+192+10 maps (Dehra Dun: Trigonometrical Survey.) 4 rupees, 8s.

Proceedings of the United States National Museum. Vol. 65, Art. 9: A Revision of the West Indian Coleoptera of the family Buprestidae. By Warren S. Fisher. (No 2522.) Pp. 207. (Washington: Government Printing Office.)

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 26, Part 1, 1925. Pp. 106+11 plates. (London: Edward Stanford, Ltd.) 5s.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 23, Part 4: Trees and Shrubs of Mexico (Passifloraceae-Scrophulariaceae). By Paul C. Standley. Pp. 849-1312+xxxix. (Washington: Government Printing Office.) 60 cents.

## Diary of Societies.

SATURDAY, MAY 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (I.).

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Brighton), at 3.30.—Dr D. Forbes: The Climate of Brighton.

MONDAY, MAY 25.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Brighton), at 3.30.—Dr D. Forbes: The Climate of Brighton.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—C. W. Wardlaw: Size in Relation to Internal Morphology. No. 2. The Vascular System of Selaginella.—J. Thomson: The Parasitism of *Cladophora* by *Roxb*.—S. Williams: Some Points in the "Anatomy of *Cladophora*".—Dr A. E. Trueman and Miss Williams: Studies in Ammonites of the Family Echioceratidae.

ROYAL SOCIETY OF MEDICINE (Odontology Section) (Annual General Meeting) (at Royal College of Surgeons of England), at 5.30.—E. W. Fish: Circulation of Lymph in the Dentine (Preliminary Report).

SOCIETY OF GLASS TECHNOLOGY (at Royal Society of Arts), at 7.30.—Prof. W. E. S. Turner: The Nature and Constitution of Glass.—Prof. G. Tammann: On Glasses as Supercooled Liquids.—Dr F. Eckert: Some Remarks on the Constitution of Glass.—Dr A. Q. Tool and E. E.

Hill: On the Constitution and Density of Glass.—Prof. H. Le Chatelier: On the Viscosity and Allotropy of Glass.

ROYAL GEOGRAPHICAL SOCIETY (at Eolian Hall), at 8.30.—Col. C. H. D. Ryder: The Demarcation of the Turco-Persian Boundary in 1914.

TUESDAY, MAY 26.

SOCIETY OF GLASS TECHNOLOGY (at University College), at 2.30.—Sir W. H. Bragg: The Structure of Quartz and Silica.—V. H. Stott: The Viscosity of Glass.—Dr G. W. Morey and Dr N. L. Bowen: The Melting Relations of the Soda-Lime-Silica Glasses.—Dr A. A. Lebedeff: Polymorphic Transformations in Glass.—Dr G. W. Morey and Dr R. W. G. Wyckoff: X-ray Studies of Soda-Lime-Silica Glasses.

ROYAL DUBLIN SOCIETY, at 4.15.

LINNEAN SOCIETY OF LONDON, at 5.—Anniversary Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. R. Whiddington: The Passage of Electricity through Vacuum Tubes (Tyndall Lectures) (II.).

ROYAL SOCIETY OF MEDICINE, at 5.30.—Annual General Meeting.

BRITISH SOCIETY OF MASTER GLASS-PAINTERS (at Art Workers' Guild, 6 Queen Square, W.C.1.), at 6.—Annual General Meeting and Exhibition of Cartoons and Photographs of Stained Glass.

ROYAL SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—The Art of the Picture.

ROYAL ANTHROPOLOGICAL INSTITUTE (at Royal Society of Medicine), at 8.30.—Dr H. F. B. Walker and others: Discussion on Miscegenation in South Africa.

WEDNESDAY, MAY 27.

ROYAL SOCIETY OF ARTS, at 4.30.—Sir Alfred Mond, Bart.: The Unemployment Problem.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section) (Annual General Meeting), at 5.—Dr J. H. Sequeira: Parasitic Affections of the Skin communicated from Animals to Man.

ROYAL MICROSCOPICAL SOCIETY (Industrial Microscopy Section), at 7.30.—Dr J. A. Murray: Lecture on the Microscopy of the Microscopical Preparations. III. Staining.—The Microscopy of Microbiology.—G. Thornton: Soil Bacteria; D. W. Cutler: Soil Protozoa, Mrs. B. M. Roach: Soil Algae.—Dr W. B. Brierley: The Microscope and Plant Pathology.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—L. S. Penrose: The Relation of the Pleasure-Pain Principle of Freud to the Question of Growth.

THURSDAY, MAY 28.

ROYAL SOCIETY, at 4.30.—R. J. Ludford: (a) Cell Organs during Secretion in the Proctoderm; (b) Nuclear Activity in Tissue Culture.—J. Needham: The Hydrogen Ion Concentration and the Potential of the Cell Interior. A Micro-injection Study.—Dr F. W. R. Brambell: The Oogenesis of the Fowl (*Gallus Bankiva*).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. F. O. Bower: The Natural Classification of Ferns as a Study in Evolution (II.).

ROYAL SOCIETY OF MEDICINE (Pharmacology and State Medicine Section) (Annual General Meeting), at 5.30.—Dr J. Brownlee: The Health of London in the Eighteenth Century.

FRIDAY, MAY 29.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at King's College), at 10 A.M.—Prof. F. G. Donnan: Principles governing Passage through Membranes.—W. Stiles: Problems of Permeability in Plant Cells.—J. A. Hewitt: Absorption from the Intestine.—L. J. Harris: Acidimetry, Ampholytes, and Proteins, followed by a discussion by Prof. A. V. Hill, Prof. S. E. Schryver, Prof. W. Ramsden, and others.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at King's College), at 2.—H. Munro Fox: On Chlorocruorin.—E. Stedman: The Oxygen Dissociation Curve of Haemocyanin.—Dr L. Hogben: Relation of Electrolytes to Invertebrate Muscle.—H. W. Harvey: Some Variable Properties of Sea-water.—W. E. Garner: Molecular Orientation in relation to Muscle Contraction and Nervous Conduction.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Chemical Industry Club), at 8.15.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Henry Newbolt: Scenery in the Pastoral Poets.

SATURDAY, MAY 30.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at King's College), at 10 A.M.—R. Chambers and P. Reznikoff: Studies on the Plasma Membrane and Physical State of Protoplasm by Micro-dissection and Micro-injection.—C. Shearer: Child's Hypothesis.—J. S. Huxley: Some Problems of Differential Growth.—Dr W. H. Pearsall: Rates of Growth and Plant Form.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (II.).

## FREE PUBLIC LECTURES.

MONDAY, MAY 25.

IMPERIAL COLLEGE OF SCIENCE—ROYAL SCHOOL OF MINES, at 5.15.—Prof. F. A. F. C. Went: Modern Conceptions of Light Stimuli in Plants.

ROYAL SOCIETY OF MEDICINE, at 5.15.—Prof. E. Brumpt: How to conduct an Anti-Malarial Campaign (Chadwick Lecture).

THURSDAY, MAY 28.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Dr W. E. Gye: The Filterable Viruses.

FRIDAY, MAY 29.

ROYAL SOCIETY OF ARTS, at 5.15.—Prof. E. Brumpt: The Prophylaxis of Sleeping Sickness (Chadwick Lecture).



SATURDAY, MAY 30, 1925.

## CONTENTS.

	PAGE
University Grants in Great Britain . . . . .	825
Mendelianism. By Dr W. Bateson, F.R.S. . . . .	827
Tropical Medicine in the Far East. By Dr. H. Harold Scott . . . . .	830
Electrical Instruments . . . . .	831
Our Bookshelf . . . . .	832
Letters to the Editor :	
Wegener's Hypothesis and the Distribution of Micro-Lepidoptera.—Edward Meyrick, F.R.S. . . . .	834
The Intensities of Lines in Multiplets.—Prof. Henry Norris Russell . . . . .	835
The Positive Electrical Drift in the Air.—Dr. William C. Reynolds . . . . .	836
Ultra-violet Radiations and Antirachitic Substances.—Prof. J. C. Drummond and T. A. Webster . . . . .	837
Luminescence of Solid Nitrogen and the Auroral Spectrum.—Prof. L. Vegard . . . . .	837
The Elimination of Mental Defectives.—Major Leonard Darwin . . . . .	838
Exaggerated Resonance.—Sir Oliver Lodge, F.R.S. . . . .	838
Quantum Radiation.—Prof. Alfred Lodge . . . . .	838
Huxley's Contributions to the Study of the Invertebrata.—Prof. E. W. MacBride, F.R.S. . . . .	838
The Yeasts: A Chapter in Microscopical Science. By A. Chaston Chapman, F.R.S. . . . .	839
Dacca: an Experiment in University Education in India . . . . .	842
Obituary :—	
Prof. Albin Haller, For. Mem. R.S. By Sir Wm. J. Pope, F.R.S. . . . .	843
Mr. H. Ling Roth. By Dr. A. C. Haddon, F.R.S. . . . .	844
Mr. R. B. Seager . . . . .	845
Current Topics and Events . . . . .	845
Our Astronomical Column . . . . .	850
Research Items . . . . .	851
Modern Investigations of Mental Imagery. By Prof. T. H. Pear . . . . .	853
Periodicity in Weather and Solar Phenomena. By C. E. P. B. . . . .	853
The Tactile Sensory Reflex . . . . .	854
The Liming and Chalking of Soils . . . . .	855
University and Educational Intelligence . . . . .	855
Early Science at Oxford . . . . .	857
Societies and Academies . . . . .	857
Official Publications Received . . . . .	860
Diary of Societies . . . . .	860
Recent Scientific and Technical Books . . . . .	Supp. v

*Editorial and Publishing Offices.*

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NO. 2900, VOL. 115]

## University Grants in Great Britain.

THE University Grants Committee, appointed in 1919 "to inquire into the financial needs of university education in the United Kingdom and to advise the government as to the application of any grants that may be made by parliament towards meeting them," has grown into a position of authority and influence greater than its terms of reference seem, at first sight, to imply. In pursuing its inquiries year by year, not only does the Committee obtain a completer knowledge of the conditions of university work at a given moment, but it also acquires an ever deeper insight into the dynamics of university economy. Inevitably, and to the great advantage of the universities, attention is concentrated less on the problem how to "carry on" and more on the trends of existing activities, their fitness for the purposes they are supposed to serve, and the values of those purposes. While the Committee is careful to disclaim the wish to impose, or, indeed, the ability to propound, an ideal common policy, it cannot escape the necessity of attempting to evaluate conflicting university ideals. Each year since 1920 it has published statistical returns submitted by the universities and university colleges in receipt of Treasury Grant, and has prefaced the returns with introductory notes. This year the returns (for 1923-24) are published as an appendix to a comprehensive report,<sup>1</sup> forming a sequel to the Committee's first report dated February 3, 1921.

The present report surveys the whole field of university education in Great Britain in the light not only of the statistical returns, but also of observations made in the course of a series of visits of inspection carried out by the Committee in 1924 with the object of seeing what progress had been made since the similar visitation of 1920. The Committee found that these four years have been years of real progress in regard to conditions of service of university staffs, the standards of teaching and research, the provision of adequate buildings and equipment, and the development of the social life of the students. Further improvement under all these heads is, however, urgently called for, and it is therefore a matter of urgent necessity that the universities and colleges should do all in their power to raise additional funds from local public bodies, industries, and private benefactors. In order to stimulate such efforts, the Committee announces that in distributing any additional money that may be voted it will continue to take serious account, wherever that can fairly be done, of the extent to which local support has been forthcoming, without, however, being bound to any

<sup>1</sup> University Grants Committee. Report, including Returns from Universities and University Colleges in Receipt of Treasury Grant, Academic Year 1923-1924. Pp. 44. (London: H.M. Stationery Office, 1925) 3s. 6d. net.

precise formula. It concludes with an exhortation to regard endowment funds as the central source of revenue, as only by the consolidation of a stable and substantial income from independent sources can the autonomy and progressive development of a university be assured.

Although there are now 57 per cent. more full-time students at British universities and colleges than before the War, their number is still comparatively small. The President of the Board of Education has lately directed attention to the fact that as yet less than 4½ per cent. of all the children in grant-aided secondary schools go on to a university, and less than 9 per cent. of elementary school children go on to secondary schools. Both of these proportions are likely to increase. The Committee points out that the increase in the flow of students from the secondary schools to the universities will inevitably tend to heighten the importance of close co-operation between the university and school authorities upon questions of curriculum and teaching method, and, it may be added, the importance of the methods of admission. At present it seems impossible for the schools to satisfy the university teachers, because these cherish two apparently conflicting ideals. On one hand, they decry "premature" specialisation in the schools and say they prefer students to come up to the university with a good foundation of general education. On the other, they want the schools "to relieve them of some of the less advanced work which they consider is now unduly taxing their time and energies, to the detriment of the higher studies which are the university teachers' proper business."

In the United States of America, where co-operation has been so close that admission has been largely by certificate of the completion of so many hours of high school work, there is urgent need, says the President of the Carnegie Foundation for the Advancement of Teaching, for the recasting of the existing entrance requirements so as to prevent the wholesale admission of the unfit and the consequent lowering of the plane of intellectual life. The Committee states explicitly that it does not think that in Great Britain there is any immediate danger of such evils, but adds that it may be well to remember, as we develop our plans, that there will be constant need for a clear conception of the true functions of university education. The Committee proceeds to indicate its own views on the question of these functions with reference to certain practical questions.

For careers in the higher branches of commercial and industrial business administration, as for the upper administrative divisions of the civil service, a university training is valuable, in the opinion of the Committee,

rather for the alertness of mind and capacity for taking broad views which it fosters than for specialised knowledge of the details of business. Dealing with the subject of the growth of specialisation, it notes with approval the policy of broadening the basis of the studies in all faculties, of breaking down the rigid barriers that specialisation tends to erect between subjects, and of insisting on giving students a clear sight of the wood as well as of the trees. The old antagonism of science and the humanities is giving place to a recognition of the fact that their proper relationship is one of active friendship, manifested, not by giving science students a smattering of the humanities, and vice versa, but by "the teaching of science and the humanities in such a way as to reveal their relationship to one another and their respective places in the wide world of human knowledge and endeavour." It would be difficult to find a more apt formula for expressing the philosophic point of view which should characterise the work of institutions of university standing.

From a consideration of the prospects of increased demands for university education, the Committee passes to the question of supply. The paragraphs which deal with this question will be read with dismay by those, if there be any, who have been looking to the Committee for encouragement of schemes for establishing new universities or colleges. First and above all, says the report, universities stand for quality, and although the capacity of organisations the essence of which is spiritual cannot be satisfactorily measured by money standards, the progress of university work under modern conditions is largely controlled by material factors.

For some years ahead, all the material support that can be expected from the State, from local authorities, and from private benefactors will be barely enough to keep British universities in a state of efficiency and provide for their expansion on a reasonable scale; nor are there sufficient grounds for believing that, given such expansion, they will not be able to meet all the needs likely to arise at much less cost than would be incurred in creating new universities or raising to the university level institutions which are now below it. In this connexion the Committee specifies 150,000*l.* a year as the minimum income for maintaining a university of the modern civic type with moderate-sized faculties of arts, pure science, medicine, and technology at the level of efficiency demanded by the requirements of the present day. It is perhaps in meeting with a steadfast and uncompromising "No" proposals with the objects of which the Committee is fully in sympathy, but which imperil the integrity of university standards, that the

Committee performs its greatest, if most disagreeable, service to the community.

Discussing the application of the policy of respecting the autonomy of the universities and, accordingly, recommending block grants in aid of general income rather than grants for specific purposes or to particular departments, the Committee makes some trenchant criticisms of the system under which the University of London is not in any real sense master in its own house: "Nowhere does the familiar problem of overlapping and duplication need to be more carefully and constantly watched than in London University, with its multiplicity of teaching institutions, and nowhere is the central machinery for dealing with it so inadequate." Perhaps the Departmental Committee now sitting will provide a solution of this problem.

Residential halls now accommodate only about 14 per cent. of the total number of full-time students of universities and colleges in Great Britain outside Oxford and Cambridge, and there is a strong demand for additional accommodation. Of the various types now in existence, the Committee favours that which approximates most nearly to the colleges of the older universities, providing not only board and lodging, but also a library and such amenities as gardens and tennis-courts, including among its residents some of the unmarried members of the university staff, and being under the supervision of a Warden of good academic standing. It specifies in some detail what experience suggests as the most important elements in halls of this type.

In the equipment of faculties of technology some institutions have endeavoured to provide full-scale apparatus, and thus to save their students from having to get experience and training in outside workshops and factories. The Committee discountenances such attempts, and holds that a selection of up-to-date plant sufficient for a thorough training in technological principles is all that a good university teacher needs.

The present needs and problems of universities in respect of these and many other matters, such as the status of university teachers, libraries, appointments boards, post-graduation scholarships, and adult education, are dealt with in the twenty-seven pithy and readable pages of this report in a way which gives it great value, not only for the institutions directly concerned, but also for universities in all parts of the Empire. It is an authoritative statement of the present position and prospects of the universities of the British Isles, and as such it should receive the earnest consideration of all who are in any way concerned with university or other higher education.

### Mendeliana.

- (1) *Carl Correns: Gesammelte Abhandlungen zur Vererbungswissenschaft aus periodischen Schriften, 1899-1924.* Pp. ix + 1299 + 4 Tafeln. (Berlin: Julius Springer, 1924.) 96 gold marks.
- (2) *Gregor Johann Mendel: Leben, Werk und Wirkung.* Von Hugo Iltis. Pp. viii + 426 + 12 Tafeln. (Berlin: Julius Springer, 1924.) 3.60 dollars.

(1) **I**N honour of Prof. Correns's sixtieth birthday, the German Society for the Study of Heredity has reprinted most of his papers relating to genetical subjects. They compose a very substantial volume of 1300 pages. The subjects of this prolific labour have been numerous, but after his large work on cross-breeding the varieties of Maize, Correns has mainly been occupied with two of the most intricate problems of botanical genetics, the transmission of variegation and the determination of sex in plants. Regarding the first of these phenomena, owing to the vast diversity in the physiological nature of the several kinds of chlorophyll defect, general expressions are obviously unattainable. Variation, in fact, is a symptom. Everything depends on diagnosis, which though sometimes easy is commonly difficult and evasive. Through contemporary work, especially that of Correns, those who come after will at least find the facts set out ready to be disentangled.

The problem of sex-determination in plants is still more complex, and no simple and generally acceptable solution is yet in sight. The tendency of modern opinion is in favour of the view which Correns himself has advocated, that in dioecious plants the male is the heterogametic sex, but this interpretation is not wholly free from objection. In plants, as also to some extent in animals, an outstanding difficulty is the complete absence of any satisfactory account of the relationship of the hermaphrodites to the sexual forms. Correns was the first to observe the remarkable fact that in gynodioecious plants the offspring of females are generally in a large majority females, those of the hermaphrodites consisting predominantly, sometimes entirely, of hermaphrodites. This is now recognised as being only a special case of a system of inheritance governing that of a great variety of characters. The essential phenomenon is genetical inequality between the eggs and pollen-grains of the same plant, of which many examples are now familiar, the inheritance of double flowers in the Stock being the original and classical illustration. The simplest interpretation, to which many of us in England have inclined, is that a segregation, probably somatic, has occurred prior at least to maturation, but those who, like Correns, are unwilling to admit anything which conflicts with the

strict chromosome-theory, seek for some other account. Much ingenuity has been devoted to an attempt to demonstrate the existence of the missing class of pollen-grains, and the numerous papers dealing with this vexed question form a prominent feature of the present volume. Even if it were proved that pollen-grains of the missing classes—always recessive by the way—are produced by the plant in the normal proportion, the peculiarity in their behaviour would remain to be accounted for.

Correns was, of course, one of the rediscoverers of Mendel, in a sense, perhaps, *the* rediscoverer. The earliest papers in this volume recall that curious and diverting episode, and the cryptic nature of the first announcements. In view of all that has happened since, he may, in any case, find satisfaction in remembering that in 1902, some time before linkage had been observed as an actual fact, he made a suggestion (p. 304 in this collection) as to the linear arrangement of elements in chromosomes and as to the exchanges between them, now spoken of as crossing-over, which in all essentials is that now adopted by the orthodoxy of the day.

The frontispiece reproduces a portrait-drawing of the author by Hans Meid, which is a very brilliant performance, both as an exact and penetrating portrait and as a piece of artistic workmanship. In spite of its high price many libraries should get this book, for several of the papers here assembled from various journals will be in requisition for some years to come.

(2) Contrasted with the imposing length of Prof. Correns's output, the slender memoir which, by the piety of Dr. Iltis, of Brunn, tells us all we are ever likely to know of Mendel himself, makes a modest appearance. The story of his life is in outline familiar. Any details about such a man are welcome, and the few new facts and anecdotes now first made known help us in some measure to reconstruct his personality, but the generation that knew him during the years of his scientific work had almost passed away before his fame began, and as to many essentials we have nothing but surmise.

It is the old story of the boy of sturdy peasant family noticed by an intelligent teacher and selected for education and promotion. We learn that in his village school some natural history was taught at the instance of the great lady of the place, an advantage which no Gymnasium would have supplied. The children even saw something of fruit-growing and bee-keeping in a garden attached to the school, so much so that an inspector, reporting on the school to the Archbishop's Consistory, complained of this disorder (*Wachsthum dieses Unfugs*), which he said was chiefly due to the machinations of a certain Pfarrer Schreiber.

That gentleman had done much to promote fruit culture in the district, and as it is also known that Mendel's father took special interest in fruit-growing, we may take it that nature and nurture seem thus to have combined happily for once. Regarding the later stages of his education, details are tolerably full. As a curiosity may be mentioned two fragments of an academic poem in praise of Gutenberg, which, though rather wooden and rough, is not without imagination. It was written when Mendel was seventeen or eighteen, and is interesting as containing the following lines, addressed to the movable types :

Ihr sollet nach des Meisters Wunsche  
Des Aberglaubens finstre Macht,  
Die lastend sich auf Erden walzt,  
Zerstreun.

an ominous beginning for a future Prälat, as Dr. Iltis observes.

The funds for his further education were provided by a sort of mortgage of the small paternal property to Mendel's brother-in-law—a remarkable document which survives. It gives a full inventory—two horses, four cows, one heifer-calf, one bull-calf, etc.—so that a clear picture of the family circumstances is before us. Being destined for orders and the teaching profession, he was sent for his continued education in "Philosophy" to an establishment at Olmütz, where his health seriously broke down more than once. Financial difficulties also supervened, and, as Dr. Iltis says, it hung by a hair whether there should be one peasant the more and one immortal discoverer the less in the world. Money was found by the devotion of a sister, then unmarried (whose three sons afterwards became Mendel's especial charge). But the strain to health lasted, and Mendel, when his course of "philosophy" was at length over with distinction, felt unequal to renewing such an effort and consulted a certain Prof. Franz as to his future. Franz had some influence with the Brunn cloister, and, having great confidence in Mendel's character and abilities, got him admitted to the brotherhood.

The chief authority for this part of Mendel's career is a brief autobiography which he prepared later on (*æt.* 28) when he was a candidate for a permanent post as a teacher in the Znaim Gymnasium. He had already a post as assistant in this Gymnasium, but in order to become permanently appointed, he required a certificate of official recognition. The procedure on this occasion (1850) strikes us as singular. He had first to supply a full and intimate history of his career, mental development, etc., together with an inquisitory report on his behaviour from the teaching staff of Znaim. They speak well of him, the only charge they have against him being that he had been six times to the theatre,

admittedly a venial error since on each occasion he had gone in the company of a colleague. The next step was the preparation of what must have been almost small treatises, one on meteorology, the other on a geological subject, for which six or eight weeks was allowed. These were referred to experts, and, in addition, to a literary assessor, who all reported upon them at elaborate and pedantic length. Ultimately, on the unfavourable verdict of the geologist, he was rejected. The papers with the reports have been preserved. We get the impression that if the business of academic education was always conducted on those lines, he was well out of it. He would have had little time for peas. So he returned to the Brunn fraternity, teaching without a qualification. The failure anyhow had one very good consequence, for it led indirectly to his being sent to the University of Vienna for two years, apparently with a subsidy from his cloister. In 1856 he made a second attempt to obtain the official qualification necessary for the teaching profession (p. 59), offering then physics and natural history. The result is not clearly recorded, but he was evidently rejected, for until he became Prälat he always figures as "Supplent," not lecturer or professor like his colleagues. None the less his fame as a very successful teacher still survives in Brunn, and these incidents provide ironical commentary on the public utility of a highly regulated educational system.

Mendel's pupils contribute the interesting reminiscence that at some early date one of his two rooms at the cloister was given up to birds and to mouse-breeding, and his biographer conjectures that possibly dominance and segregation were first seen in the mice. Dr. Iltis points out that some experiments with peas must have been already in progress in 1854, for in that year Mendel published an observation on *Bruchus pisi*, which had been damaging peas near Brunn. His interest in the species problem was probably aroused by Gärtner's experiments, though that must be uncertain. How the work fell unnoticed we all know. In spite of an exchange list of 120 copies which went to the various libraries and 40 private *separata*, not one soul took any heed of it. He remained alone. After his immense labour he found not a single creature who understood, not one who believed him. As bad luck would have it, he then started on Hieracium, and then in an evil moment he tried to interest Nägeli, whereupon ensued that tragic correspondence which completed the catastrophe. Nägeli understood him no better than the citizens of Brunn, and, after waiting two months, replied from Olympian heights that the pea experiments seemed to have only just begun, and that he had better go on with Hieracium. The later letters all relate to Hieracium. Nothing more is said

about the peas. Nägeli is known to have sown the peas which Mendel sent him, but there is never a word as to how they behaved. Hieracium must have been a crushing disappointment, for apogamy was not discovered until long after. That was not Nägeli's fault; but perhaps we may draw the moral that a discoverer of something really new, wishing to find sympathy and encouragement, does not act wisely in appealing to the highest established authority on that particular subject. Dr. Iltis pessimistically remarks that his remedy would have been to have published it all in a "stattliches Buch," as no modern investigator would have neglected to do—something more like Correns's, in fact. This course, nevertheless, has also been known to fail.

All attempts to find the records of Mendel's experiments on bees have failed. We have only the plan of his hives, preserved by the carpenter. He worked on many other subjects, notably Fuchsia, but of these investigations also the results are lost.

We have next a full account of Mendel's meteorological observations, and the life concludes with a detailed history of his "fight for right" against the vindictive taxation of religious houses which was instituted by the Austrian Government in 1874, another painful story. At first he was backed up by the heads of other convents and by the brethren in his own, but after a while they all abandoned the struggle. Once again, in this last enterprise, he was utterly deserted and alone. His obstinacy was such that doubts of his sanity were professed. Whether he was right or wrong it is hard to say, but at least he bore himself throughout as a brave and resolute man should.

The second half of the book gives an account of Mendelian doctrine and its later developments up to the present time. This is very well done, and it supplies in a compact form as good an epitome of the modern science of heredity as has yet appeared.

Dr. Iltis is convinced that Mendel was virtually a freethinker, and only officially a Catholic, interpreting various details in this sense. That he had no special call to clerical work is clear. In his early days this was commented on by a superior who, reporting to the Bishop that he led a modest, religious life, combined with much zeal for the sciences, adds that he had little aptitude for the care of souls. Ministration to the sick and dying distressed him so much as to induce serious illness, presumed to have been a sort of hypochondria. Without much stronger evidence I should hesitate to accept Dr. Iltis's judgment, which is tantamount to a charge of active insincerity. Rather I should suppose that Mendel's position was that of numberless honest men in all ages the world over, who can take things as they find them. Nothing at all suggests that

considerations of faith or doubt had much interest for him, or that he was ever in the position of having to take a side on such questions. Probably they never troubled him one way or the other. I imagine Mendel as a man full of practical good sense, with an exceedingly clear head, thinking in well-divided compartments, rarely disturbed by the eccentricities of genius. We are told that he was not given to brooding or to sentimentality, that he was devoid of music and cared nothing for "Belles Lettres." But when roused he showed, nevertheless, that he had in him a strong element of the martyr, as appears very plainly from the protracted resistance to authority which embittered the last ten years of his life; and *prima facie* such a man is scarcely one whom we need suppose consciously guilty of long-continued sophistry or dishonourable compromise. With this reservation we may be grateful to Dr. Iltis for a masterly book, in which all too scanty materials have been used to the greatest advantage, and not least for having rescued one most excellent photograph (p. 53), from which we can at last see exactly how Mendel looked at about the time of his discovery.

W. BATESON.

### Tropical Medicine in the Far East.

*Far Eastern Association of Tropical Medicine. Transactions of the Fifth Biennial Congress held at Singapore 1923.* Edited by the Hon. Dr. A. L. Hoops and Dr. J. W. Scharff. Pp. xx + 974 + 86 plates. (London: J. Bale, Sons and Danielsson, Ltd., 1924.) 40s. net.

THE report of the transactions of the fifth biennial congress of the Far Eastern Association of Tropical Medicine, held at Singapore in September 1923, forms an imposing volume. Since time and distance rendered it impossible to send proofs of the various papers to the authors for correction or revision, a very high meed of praise is due to the editors, Dr. A. L. Hoops and Dr. J. W. Scharff, for the excellent way in which they have performed their arduous work. Previous congresses had met in Manila (1901), Hong Kong (1912), Saigon (1913), and Veltevreden (1921). The president-elect for this, the fifth congress, was Dr. A. E. Horn, who, however, had in the meantime been appointed medical secretary at the Colonial Office and was, therefore, unable to be present, the chair being taken by Dr. A. L. Hoops.

Of the seventy-eight papers submitted, all except five are reproduced in this volume. In a review such as this it is obvious that all cannot be mentioned in detail, and where there is such a feast of good things, it is a somewhat invidious duty to have to make a selection.

The presidential address is an example of what such an address should be—not a detailed account of some

special matter to which the author has particularly devoted himself and which may be of little interest to a large proportion of his audience, and, from its very nature as a presidential address, not open to criticism and discussion; it is an introduction on matters of general interest, in this instance "The Prevention of Disease in the Tropics." A series of papers dealing with malaria and cognate matters occupies the foremost place among the more detailed scientific communications. The opening address, by Sir Malcolm Watson, constitutes an excellent brief review of a vast subject and points out the important fact, too often forgotten or neglected, that all malarious districts cannot be dealt with by a single uniform method, that the prevalent idea of indiscriminate clearing of jungle or bush may do more harm than good by getting rid of non-malarial mosquitoes and facilitating invasion by malaria vectors. This is well exemplified in a concrete instance by the succeeding paper on the "History of Malaria at Gemas." Dr. Howard deals with control of the disease on Malayan rubber estates, and Dr. Walch's paper is stimulating as paving the way for investigations into the reasons why one species of *Anopheles* may carry malaria in a district while others fail to do so. Lieut.-Col. Christophers contributes an enlightening paper on a method of more accurately measuring and expressing the results of examination for splenic enlargement in children than that generally in vogue, in that the notation recommended shows not merely the degree of enlargement but also that of displacement. The paper on the "Treatment of Dementia paralytica by Malaria Inoculation" will be read with interest by alienists in England and other places where the method is now on its trial.

Dr. Fitzgerald writes on the fascinating, though little understood, conditions of amok and latah, and Sir David Galloway follows with a more detailed account of the former of these. Dr. Stanton sheds further light upon the vexed question of beriberi and its control. He discusses briefly various theories which have been advanced from time to time, and, so far as is possible in the case of a disease of still undetermined etiology, bases the measures of control on a scientific foundation. Dr. Noel Bernard contributes an account of his researches into the relation, or possible relation, with beriberi of the organism isolated by him from the blood of certain patients with febrile and asthenic symptoms, and denominated the *Bacillus asthenogènes*. Further evidence will be needed to convince the impartial critic of its causal connexion with beriberi. As the last of the beriberi series, Lieut.-Col. Megaw summarises the beriberi problem in a paper which will be of interest to research workers and practitioners alike. He points out that not only isolated cases but also explosive outbreaks of this disease occur in which food deficiency

can apparently be excluded, and he also stresses the fact that the question of possible poisons in rice has not yet been efficiently studied.

Another group, of six papers, are devoted to ankylostomiasis. The paper by Prof. de Langen on the toxic origin of the anæmia in this infection is of outstanding scientific interest. Dr. Wu Lien-Teh writes as interestingly as ever on pneumonic plague, a subject which he has made peculiarly his own. There are six contributions on leprosy. Two of these deal more particularly with medicinal treatment, three with statistical and administrative aspects, and one with the ocular conditions and complications. This last is good reading, but partakes rather of the nature of a compilation.

The latter half of the report will be widely read by tropical practitioners. It comprises thirty-five papers of a miscellaneous character. Unfortunately, space will not permit of our referring to all of them. They range from a paper proposing the question, "Has Parasitology a Place in the Medical Curriculum?" to one on the chemical composition of gall-stones. The title of the former should be "Ought Parasitology to have a Place?" Considering that the audience consisted of tropical practitioners, the answer might be expressed in a single word. Of the remainder, special mention must be made of the following:—(1) The article "L'Ascariodose chirurgicale," by Prof. Le Roy des Barres, since this subject has of late been frequently brought to the notice of those practising in temperate climates also; (2) that on the interpretation of the microscopic picture in dysentery, which covers more than the title would lead one to infer, and points out the great importance for all medical men working in the tropics to have some degree of laboratory experience; (3) pseudo-typhus of Sumatra; (4) two papers on Encephalitis lethargica, the first from the clinical, the second from the experimental point of view; (5) Prof. Toyama's interesting and instructive paper on lacquer dermatitis; (6) lastly, Sir David Galloway's paper on opium-smoking. The last named does not appear from the report to have elicited as much discussion as it deserved. The reputed harmful effects of this habit, or rather custom, are matters about which we would have liked to hear more at such a gathering as this, where many of the audience must have had first-hand experience. We are more than glad to see that he maintains the view that opium-smoking is comparatively innocuous; at all events considerably less harmful than the habits which the opium-smoker develops when this indulgence is denied.

As regards the work in general, the misprints are remarkably few for so large a production, as are also mistakes in nomenclature, of which we may cite *Ankylostoma canium*. The papers from Japan lose something of their value by treating too much of the

historical aspects of the subjects, after the manner of a German doctorate thesis, and we note that in an article on recent progress in parasitology made by Japanese investigators, such matters as the mode of infection by *Ancylostoma larvæ* (1912), that of *Ascaris* discovered by Stewart in 1917, the discovery of *Metagonimus yokogawai* which occurred in 1910, and the life-history of *Paragonimus westermanii* worked out ten years ago, all receive detailed accounts. This might have been omitted and the space thus set free could have been profitably given up to an index, which would further enhance the value of a volume such as this. The photographs and illustrations are mostly good and are excellently reproduced, and the standard of the various contributions is, on the whole, so high that the Far Eastern Association, if future conferences maintain the standard of the last, will gain a world-wide reputation for advancing materially the solution of the many still obscure problems of tropical medicine.

H. HAROLD SCOTT.

### Electrical Instruments.

*Electrical Measuring Instruments.* By Dr. C. V. Drysdale and A. C. Jolley. Part 2: Induction Instruments, Supply Meters and Auxiliary Apparatus. Pp. 475. (London: Ernest Benn, Ltd., 1924.) 55s. net.

THE first volume of Messrs. Drysdale and Jolley's work on electrical measuring instruments, which was noticed in NATURE of August 30, 1924, p. 304, dealt with commercial and indicating instruments. In the second volume, which has recently appeared, the authors carry the work a stage further, covering supply meters, induction instruments and auxiliary indicating instruments.

The opening chapter contains a detailed description of the various types of supply meter and demand indicator. There have been several books published already on electricity meters which cover the same ground, and one is inclined to criticise the inclusion of some types of meter which are now almost obsolete. As in the previous volume, the instruments are described in great detail and much practical information is given about their mechanical construction. The tables of temperature coefficients of supply meters and the curves showing the effect produced by tilting will be of value to Central Station engineers who have to use them.

"Induction" instruments are dealt with in the next chapter, which is one of the most complete and exhaustive studies of this type of apparatus that have yet been published. The theory of the induction ammeter and voltmeter and of the induction type wattmeter and energy meter (including the Sumpner

wattmeter) is given. A valuable table showing the torque exerted and the power consumed by induction supply meters is included, and a considerable section of the chapter deals with the "shaded pole" type of instrument. The simplicity of the induction type supply meter has encouraged its use, but, as the authors point out, these meters require the most careful design if they are to give accurate records of the energy used in a supply circuit. This chapter is characterised by the same care and thoroughness of treatment as the preceding parts of the book.

The chapter on recording instruments is also very complete. Not only are the more usual types of recording instruments mentioned, in which the record is made by a moving pen, but also those giving intermittent records by the puncturing of paper by a spark.

A chapter is given to the various forms of frequency and phase meters. The types of frequency meters described include those with vibrating reeds as well as the electro-magnetic type; power factor meters are discussed and the chief types described. Devices for increasing the range of alternating current instruments occupy another chapter, which is concerned mainly with the various forms of potentiometer, and with potential and current transformers. The literature of this subject is very meagre, and the information included will be of value to those who have to deal with the design of these instruments.

A very important chapter deals with devices for mechanical testing, that is, with tachometers, stroboscopic instruments, brakes (including the well-known eddy current brake), and torque recorders. Later, a description is given of synchronising devices and synchronoscopes, and leakage indicators, ohmmeters, and the well-known "megger" are described.

The final chapter deals with test-room equipment, and includes a description of the apparatus necessary for the calibration of indicating instruments, the most important of which is the A.C. potentiometer. Methods of checking the accuracy of meters and a description of some standard forms of wattmeter are given. The last few pages give a short account of some of the bridge methods now used so extensively in connexion with telephone work for measuring capacity, self-induction and mutual induction, as well as apparatus for testing the magnetic quality of iron.

Although the two volumes cover a wide field, the work is still incomplete. If the authors could see their way to publish a third volume, such as is suggested in the preface, which would deal with laboratory instruments, the value of the book would be much increased. The two volumes that have been published already, however, are a mine of information on electrical measuring devices.

### Our Bookshelf.

*Psychology and the Sciences.* Edited by Dr. William Brown; with Contributions by Dr. J. S. Haldane, Dr. R. R. Marett, Dr. F. C. S. Schiller, Dr. L. P. Jacks, Rev. A. E. J. Rawlinson, Dr. M. W. Keatinge, Dr. William Brown, Dr. T. W. Mitchell. Pp. vii + 184. (London: A. and C. Black, Ltd., 1924.) 7s. 6d. net.

It was a happy inspiration of the Wyld reader of mental philosophy at Oxford to gather together the views of representative thinkers in various branches of science with regard to the relations of psychology to the kindred sciences which they represent, either on the philosophical or biological side, as well as to certain applications of psychology to education and medicine. Though written on popular lines, the volume is an interesting one; for the authors of the essays, which were originally delivered as lectures at Oxford, have taken their several tasks seriously; and, writing from quite different points of view, have emphasised several important conclusions. One of these is that psychology must be regarded as a legitimate science, following its own scientific methods by using interpretative categories peculiar to itself; and another, that it provides a viewpoint necessary as a completion to those of the other sciences represented by the writers of the essays.

Dr. Haldane's contribution is noteworthy, as stressing the necessity of psychological categories of interpretation as well as biological ones, and denying the possibility of expressing the facts of either science in physical terms. Dr. Mitchell's paper is a guarded statement of the relation of psychology to the facts and conclusions of psychical research. The editor's own essay is a reasoned justification of the claims of applied psychology, in one of its principal departments, to an unprejudiced hearing. The sciences with which psychology is compared in the volume are biology, anthropology, logic, ethics, theology, education, medicine, and, if it may be called a science, psychical research. As a symposium on these relations "*Psychology and the Sciences*" is worth attention; though, of course, it is not the last word on the subject.

*Handbook of the Geology of Ireland.* By Dr. Grenville A. J. Cole and T. Hallissy. Pp. viii + 82. (London: Thomas Murby and Co., 1925.) 8s. 6d. net.

THE work is based on the late Prof. Cole's contributions to the "*Handbook of Regional Geology*," published some years ago in Heidelberg, and revised and brought up-to-date by him in collaboration with Mr. T. Hallissy. It is an authoritative and concise statement of the broad features of the geological structure and history of Ireland, and though the size of the volume does not allow of much detail, lists of the various papers dealing with the subject-matter are given at the end of each section.

The general morphology of the island is dealt with, and then follow a number of chapters each dealing with the stratigraphy, distribution, and lithology of a system. Tables giving the correlation of the Devonian rocks of Ireland with those of Britain and the Continent of Europe are included.

Under the heading "*Quaternary*" is given a

description of the glacial deposits of the country, and the authors support the views held by Close with regard to the centres of distribution of the ice, and those of Hull on the origin of the sands and gravels which sometimes occur between two layers of boulder clay. Both these views have been placed in grave doubt by recently published work, and though some of the papers are included in the bibliography, they are not discussed in the text.

Section III. is an account of the general geological history, and contains much that is calculated to stimulate thought, as does also the following section on orographic elements. The volume concludes with an account of the principal minerals of economic value found in the country.

The illustrations include a geological map of Ireland and several sections, but during perusal the lack is felt of a map showing the positions of the various topographic features and towns mentioned in the text.

*The Year-Book of the Universities of the Empire, 1925.*

Edited by W. H. Dawson. (Published for the Universities Bureau of the British Empire.) Pp. xii+808. (London: G. Bell and Sons, Ltd., 1925.) 7s. 6d. net.

THIS Yearbook, published for the Universities Bureau of the British Empire, has established a claim to be considered not only a useful but an indispensable work of reference for all who are concerned with higher education and research.

The latest edition has just come to hand. Included in a little more than 800 pages are a general survey of the British universities, very full particulars of all the universities within the Empire, as well as some shorter notes regarding the other universities of the world. The book contains also among its valuable appendices information regarding the conditions of entrance to the professions, the various matriculation and other entrance examinations, inter-university scholarships, grants for research, etc., and, what is particularly useful, a list of subjects for specialised study in the universities of the United Kingdom.

A considerable amount of hard work must have gone to the compilation of this volume. The universities of the Empire alone now number 67, and to obtain information regarding their affairs would, in the absence of a volume such as this, necessitate the consultation of a set of calendars constituting in themselves a library of formidable dimensions. The possessor of the volume is spared such a laborious task, and the condensation of so much information has been made possible by a system of abbreviations which is ingenious and easily followed.

We have tested the volume by frequent reference and found it remarkably accurate. It reflects credit alike upon the editor and the publishers.

*North Manchuria and the Chinese Eastern Railway.*

Pp. xiii+454+13 plates. (Harbin, China: C.E.R. Printing Office, 1924.) 6 dollars.

THIS volume was first published in Russian in 1922, but the present edition has not only been well translated, but has been thoroughly revised and considerably extended. It deals mainly with the country traversed

by the Eastern Chinese Railway in its course of some nine hundred miles from the Siberian railway to the Ussuri railway on the way to Vladivostock. In this northern part of Manchuria, settlement, mainly by Chinese, dates almost entirely from the opening of the railway in 1903, which allowed the Manchu authorities to carry out their policy of colonisation which had been initiated a few years previously. For through traffic between east and west the Chinese Eastern railway is the shortest route, but it no longer has a monopoly since the earlier designed but later constructed Amur line was built entirely within Russian territory.

A short chapter on the physical geography of Manchuria is followed by long and full accounts of the economic development of the country and the waterways and railroads. A concluding chapter deals with the operating of the railroads. The rapid growth of prosperity and the great food-producing possibilities of the country are well brought out. There are a number of illustrations, but the maps are weak. Altogether it is a useful volume on a country about which authoritative information is not too easy to obtain.

*Algebraic Geometry: a First Course, including an Introduction to the Conic Section.* By M. P. Meshenberg.

Pp. xi+127. (London: Sidgwick and Jackson, Ltd., 1924.) 3s. 6d. net.

THIS is one of the best introductions to algebraic geometry that we have seen. It is mainly intended to be used as a class-book by senior courses just beginning analytical geometry in secondary schools. Within the compass of a hundred pages the author has contrived to give a thorough treatment of the co-ordinate geometry of the straight line and circle, together with a short but very satisfying introduction to the conic sections. The student is evidently given the benefit of much practice in teaching the subject; very many pitfalls which often disturb beginners are pointed out, and the summaries will be found most helpful to learners. We confidently recommend Mr. Meshenberg's book both to teachers and to private students; it is worthy of being used very widely. W. E. H. B.

*Australasia and New Zealand.* By B. C. Wallis.

(Macmillan's Practical Modern Geographies.) Pp. x+350. (London: Macmillan and Co., Ltd., 1924.) 5s.

THIS is a useful addition to the series to which it belongs. Australia and New Zealand receive rather scant notice in most English textbooks, but Mr. Wallis's work fills the gap. He has produced a book which is full of accurate information and is particularly valuable in its chapters on climate—a difficult part of the subject, and one which is too often shirked by writers of textbooks. A great deal of statistical information is given throughout the book. This may not attract some teachers, but certainly should help to give greater precision and respect for facts in the study of geography. The book contains more than one hundred admirable maps, and above a hundred and fifty well-selected illustrations. These features alone give value to the volume.

### Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.*]

#### Wegener's Hypothesis and the Distribution of Micro-Lepidoptera.

ON the suggestion of a friend, I have tested the credibility of Wegener's hypothesis of continental displacement in the light of my knowledge of the geographical distribution of the micro-Lepidoptera, and some observations on the subject may be of general interest.

The term micro-Lepidoptera is a popular and not a scientific one, and has various acceptations, but I use it here to denote the Tortrices and Tineæ only, and (except that I shall have occasion to mention one genus of Pyrales) I shall not call evidence in support of my case from other groups of animals and plants; the different modes of distribution, periods of origin, and other conditions appropriate to these would tend rather to confuse the issue than to elucidate it. I have always thought that these fragile little insects offer especially trustworthy testimony to former land-connexion; their weak flight forbids even a short voluntary sea-voyage; though they may be carried long distances by gales, their most constant impulse is to avoid this by taking shelter, and those that fail to do so would usually be lost at sea, whilst a large proportion of the species, being restricted by habit to certain food plants in the larval stage, would be unable to establish themselves in a new country where these plants did not exist; and their mode of life is such that other means of distribution (such as ocean currents, transmission by birds, etc.) are in general entirely inoperative. Further, the extent of the group is adequate (I am acquainted with probably 30,000 species, constituting some 35 families and 2000 genera) to afford a sufficiently broad basis for reasonable argument. Naturally a full treatment is here impracticable, but it is possible to develop a few striking and well-ascertained facts.

Wegener gives three maps, reconstructing the globe at different periods. The first of these, representing the Carboniferous era, does not concern us here, since there is no evidence of the existence of any Lepidoptera before the Jurassic. It is probable (and let it be admitted) that in the Jurassic period only primitive forms of Lepidoptera existed; that in the Cretaceous the principal families, as now known, came into being; and that in the Eocene the larger existing genera (those the great specific development and extensive geographical range of which compel us to assign them an origin far back in time) were definitely established. The second map shows the hypothetical relations of the continents in the Eocene, and we see Africa (below the Sahara) and South America in near approximation, and even touching above the equator. There ought, then, to be generic evidence of this. Now *Ceromitia* (belonging to the "long-horned" *Adelidæ*, of early type) contains at present 45 African species, being the largest micro-Lepidopterous genus especially characteristic of Africa (which has not been so prolific of large genera as the other continents), and undoubtedly originated there; it also includes 7 species from the Amazonian region of Brazil, and is unknown elsewhere. This is a very remarkable distribution. *Tiquadra* (*Tineidæ*), a very distinct form of peculiar

aspect, consists of 18 South American species (extending to Mexico), and also 3 African; it is found nowhere else, and its home is clearly American. *Polyhymno* (*Gelechiadæ*) is also a genus of striking appearance, and probably of South American origin; it contains 10 American species (North and South), 16 African, and 1 Indian, which may have been derived from Africa. So far as concerns the connexion of Africa and South America, this is evidence as good as could be expected; it demands nearly some such explanation.

We must now consider the more difficult and critical problem presented by Australia and New Zealand. These are represented in the Eocene map as forming one land-mass, completely united also with Antarctica, and by an isthmus-like extension of the latter with South America, the Antarctica portion lying beneath but rather widely remote from Africa, and the Australian portion still more widely remote from India and Asia, but terminally rather approaching the Malay Archipelago. Antarctica is thus brought up into a temperate climate.

Wegener rightly recognises three elements in the Australian fauna—Indian, Malayan, and South American—and describes this feature as being "in most beautiful agreement" with his displacement theory. The South American element is expressly stated to have reached Australia through Antarctica, and as on his theory the width of the Pacific Ocean is much increased, it could scarcely arrive otherwise. *Machimia* (*Ecophoridæ*) is a considerable genus, commonly attracting attention by its rosy or crimson tints; its distribution is very striking, namely, South and Central America 73 species, North America (to Canada) 10, Japan 1, Australia (almost all East Australia) 47. Not a single New Zealand species! This is by far the best example of generic intercommunication between Australia and South America, and yet New Zealand, theoretically served by the same means of communication, has absolutely no share in the result. My explanation (and it seems to me the only possible one) is that the Japanese species gives the clue, and that the passage was made by the north; the Japanese micro-Lepidoptera are very inadequately known, and I anticipate that more of the genus will be found there. If, however, as is essential on the Wegener hypothesis, *Machimia* travelled by way of Antarctica, then New Zealand must at that time have been already disconnected and remote. But since the other evidences of relationship between Australia and South America are only small, fragmentary, or dubious (as being otherwise explicable), the evidence of relationship between New Zealand and South America should in that case be still more inconsiderable. Let us now examine that.

I mentioned above my intention to quote one genus of Pyrales, because it is particularly illuminating. *Crambus* is a genus of perhaps nearly 400 species, of which the larvæ feed usually on the roots of grass or sometimes in moss, and therefore find pabulum in all regions; it includes the familiar "grass-moths" of Great Britain (where there are 26 species), and is well represented generally throughout the world except that it thins out in the Indo-Malayan region, and is reduced in Australia to two or three wide-ranging exotic forms; there is no endemic Australian species. In New Zealand there are more than 40 endemic species, forming a very prominent feature of the fauna; they constitute a homogeneous group, with no specific affinity to Australasian forms, but akin to those of South America, which is their only possible place of origin; and I hold, as Wegener would, that they travelled

thence by way of Antarctica (though in my opinion the connexion was made westward of America, and not eastward as he puts it). Then why are there none in Australia? On Wegener's hypothesis this is altogether unaccountable.

There is, however, a further phase of the same question. If New Zealand and Australia are supposed on the hypothesis to be connected with South America by the same Antarctic isthmus, much more therefore are they connected with one another. Those characteristic Australian genera, whencesoever derived, the large development of which indicates antiquity (such genera, older than the American and Malayan elements, must be presumed to be of Indian stock), might confidently be expected to have flourishing colonies in New Zealand. The largest family in either area is the *Cecophoridae*; Australia already possesses 1500 described species. *Philobota* (containing mainly insects of fair size, and often conspicuously coloured) has 278 Australian species, 1 South African, 1 Indian, 2 New Zealand (one of which closely approaches a Tasmanian form); the non-Australian species can only be regarded as chance stragglers. *Eulechria* has 232 species in Australia (including New Guinea), 4 Indo-Malayan, 1 South African, and 1 New Zealand. In the *Gelechiadæ* the principal Australian genus *Protolechia* has 122 species and (with several minor derived genera as well) is wholly endemic, not a single species being found in New Zealand. On the other hand, the characteristic New Zealand *Cecophorid* genera *Izatha* (15 species) and *Gymnobathra* (14 species), both apparently of South American type, are quite unknown from Australia. The amount of community shown here is then no greater than might be expected if the conditions had always been as at present, with New Zealand separated from Australia by 900 miles of sea, but stretching for nearly 1000 miles parallel to its coast, so as probably to catch occasionally a stray insect blown out to sea; indeed, I should have expected a little more than is actually found. Of course there is closer relation displayed in some of the other families, which cannot be discussed here and does not affect my argument; I will only say that it can be explained generally by comparatively recent intercommunication taking place between New Zealand and Queensland by way of New Caledonia.

My conclusion is, then, that if, as appears to be the case, Wegener's views on Australia and New Zealand are an integral part of his scheme, the hypothesis is disproved by facts. I consider that there must anciently have been some better communication between South America and Africa, and that this was probably equatorial and not southern; to that extent I am in accord with him.

EDWARD MEYRICK.

Thornhanger,  
Marlborough, Wilts.

### The Intensities of Lines in Multiplets.

THE relative intensities of spectral lines belonging to the same multiplet appear to be determined by quantum conditions. The formulæ here briefly presented have been derived from the theoretical conditions imposed by the correspondence principle, and give results in close accordance with the existing observational data in all known cases.

Landé's quantum numbers,  $R$ ,  $K$ ,  $J$ , have been found to be best adapted to the problem ( $2R$  is 1, 2, 3 for the singlet, doublet, triplet systems;  $2K$  is 1, 3, 5, 7 for the  $S$ ,  $P$ ,  $D$ ,  $F$  series; and  $J$  is equal to the ordinary inner quantum number  $j$  in

systems of even multiplicity and to  $j + \frac{1}{2}$  in those of odd multiplicity). Connections between terms characterised by the quantum numbers  $K_1$ ,  $R_1$  and  $K_2$ ,  $R_2$  may occur when  $R_1 - R_2$  is 0 or  $\pm 1$ , and when  $K_1 - K_2$  has any value up to  $\pm 3$ , but the inter-system combinations for which  $R_1 - R_2 = \pm 1$ , and the few groups for which  $K_1 - K_2$  is  $\pm 2$  or  $\pm 3$ , usually give faint lines and will not be considered here. It is convenient to set  $K_1 + K_2 = 2K$ .

The more important multiplets show three types of structure (illustrated by examples from the quintet system):

Ordinary.	Rhomboid.	Symmetrical.
$x_4 y_3 z_2$	$x_3 y_2 z_1$	$x_4 y_3$
$x_2 y_1 z_0$	$x_1 y_0 z_{-1}$	$y_3 x_2 y_1$
$x_0 y_{-1} z_{-2}$	$x_{-1} y_{-2} z_{-3}$	$y_1 x_0 y_{-1}$
$x_{-2} y_{-3}$		$y_{-1} x_{-2} y_{-3}$
$x_{-4}$		$y_{-3} x_{-4}$

Ordinary multiplets occur when  $K_1 - K_2 = 1$  and  $K > R$ : that is, when the terms involved have their maximum or "permanent" number of components. "Rhomboid" groups occur when  $K_1 - K_2 = 1$  and  $K < R$ , so that the terms have less than the maximum number of components (these groups appear to have no recognised name, which may excuse coining one). Symmetrical groups occur when  $K_1 = K_2$ . The intensities of the lines are denoted by  $x$ ,  $y$ ,  $z$ , the subscripts being the values of  $l$ , when  $l = J_1 + J_2 - 2K$  when  $K > R$ , and  $l = J_1 + J_2 - 2R$  when  $R > K$ .

The equations given below have been derived by application of the principles of Sommerfeld and Heisenberg (*Zeitschrift für Physik*, 11, 131, 1922) to Landé's vector-model (*Zeitschrift für Physik*, 15, 189, 1923), using the means of the values of  $J$  and  $K$  in the initial and final states. This is found to define completely all the terms of the highest order in  $K$ ,  $R$ ,  $l$ . The terms of lower order are fixed by the condition that the formulæ shall give zero intensity for the fictitious lines which fall into the same rows or columns as real lines, but outside the limits of the multiplet. Very similar formulæ for ordinary multiplets have recently been published by Ornstein and Burger (*Zeitschrift für Physik*, 31, 355, 1925).

#### Ordinary Multiplets ( $K > R$ ).

$$x_l - u_l = 4RK^2(8K^2 + 4Kl + l^2 - 4R^2 - 1)$$

$$y_l + u_{l+1} + u_{l-1} = 4RK^2(4R^2 - l^2)$$

$$z_l = u_l = \frac{1}{4} \frac{RK}{2K + l} \{(4R^2 - l^2 - 1)^2 - 4l^2\}.$$

#### Rhomboid Multiplets ( $K < R$ ).

$$x_l - u_l = 2KR(R + K)(l + 2K - 1)(l + 2K + 1)$$

$$y_l + u_{l+1} + u_{l-1} = 4KR^2(4K^2 - l^2)$$

$$z_l - u_l = 2KR(R - K)(l - 2K + 1)(l - 2K - 1)$$

$$u_l = \frac{1}{4} \frac{RK}{2R + l} \{(4K^2 - l^2 - 1)^2 - 4l^2\}.$$

#### Symmetrical Multiplets ( $K > R$ ).

$$x_l + y_{l+1} + y_{l-1} = 4RK(4K^2 - 1)(2K + l)$$

$$y_l = 2RK \left\{ 2K - \frac{4R^2 - l^2}{4(2K + l)} \right\} (4R^2 - l^2).$$

#### Symmetrical Multiplets ( $R > K$ ).

$$x_l + y_{l-1} + y_{l+1} = 4RK(4K^2 - 1)(2R + l)$$

$$y_l = 2RK \left\{ 2R - \frac{4K^2 - l^2}{4(2R + l)} \right\} (4K^2 - l^2).$$

The sum-rules of Burger and Dorgelo (according to which the sums of the intensities in successive

rows or columns are proportional to the corresponding values of  $J$  follow as deductions from these formulæ. The sum of the intensities for the whole multiplet is in all cases  $16R^2K^2(4K^2-1)$ . The formulæ for symmetrical groups give intensity zero for the last  $\kappa$ -line when  $K=R$ . This is the line excluded by Landé's rule, both inner-quantum numbers being zero; so that this rule too (in the present case) appears as a deduction from the correspondence principle. In symmetrical groups, when  $R > K$ , the later  $\kappa$ -lines come out very faint, and when  $2K=5$ ,  $2R=7$ ,  $\kappa_2$  comes out zero. This is an excellent agreement with observed facts, previously quite unexplained.

The few published quantitative measures of line intensities are in excellent agreement with the theory. A more comprehensive test is found in King's extensive series of estimates of intensities in arc spectra. Comparison for the doublet and triplet systems shows that King's tabular numbers are very nearly proportional to the square roots of the actual intensities.

Results for some of the most characteristic and important groups are given below. For the measured groups, the sum of the computed intensities has been made equal to that of the observed. For King's estimates the sum for each multiplet has been multiplied by such a factor as to make it 100  $R$ ; means taken of the results for groups of the same type, and the square roots of the observed intensities have been similarly treated for comparison.

The  $\kappa$ 's are given first, then the  $\gamma$ 's, then the  $z$ 's (separated by semicolons); means have been taken of those observed  $\gamma$ 's in symmetrical groups which should theoretically be equal. (The observed differences are not serious)

#### QUANTITATIVE MEASURES.

##### Triplet System :

PD	Obs.	100, 54, 25 ; 19, 18 ; < 1.
	Comp.	100, 54, 24 ; 18, 18 ; 1.2.
DD'	Obs.	100, 56, 37 ; 14.5, 13.
	Comp.	102, 57, 37 ; 13, 12.

##### Quintet System :

DD'	Obs.	100, 46, 19.5, 3, 0 ; 24, 34, 24, 13.7.
	Comp.	108, 50, 18, 3.6, 0 ; 22, 29, 25, 14.4.

#### KING'S ESTIMATES.

(The figures in parentheses denote the number of groups combined to form the mean values.)

##### Triplet System :

PD	Obs.	47, 36, 25, 19, 19 ; 4.
(15)	Comp.	48, 35, 23 ; 19, 19 ; 5.
DD'	Obs.	41, 30, 25 ; 14, 13.
(5)	Comp.	40, 30, 24, 14, 14.
DF	Obs.	48, 36, 35 ; 14, 14, 3.
(13)	Comp.	48, 40, 32 ; 14, 14 ; 2.
FF'	Obs.	42, 35, 29 ; 11, 11.
(8)	Comp.	42, 35, 30, 11, 10.
FG	Obs.	50, 40, 36 ; 10, 10 ; ?
(9)	Comp.	48, 42, 37 ; 11, 11, 1.3.

#### PP' Groups.

Triplets :	Obs.	44, 18, 0 ; 24, 20.
(10)	Comp.	41, 19, 0 ; 24, 21.
Quartets :	Obs.	52, 20, 13, 28, 28.
(3)	Comp.	48, 17, 13 ; 31, 30.
Quintets :	Obs.	57, 10, 17 ; 44, 39.
(2)	Comp.	56, 16, 22 ; 39, 39.

#### PD Groups.

Quartets :	Obs.	50, 35, 23 ; 27, 28, 25 ; 7, 5.
(7)	Comp.	50, 36, 23 ; 24, 26, 23 ; 8, 10.
Quintets :	Obs.	55, 40, 23 ; 32, 31, 26 ; 10, 16, 17.
(9)	Comp.	54, 40, 24 ; 28, 31, 27 ; 11, 15, 18.
Sextets :	Obs.	70, 46, 25, 31, 35, 31 ; 15, 22, 24.
(7)	Comp.	62, 45, 27 ; 33, 38, 33 ; 14, 21, 27.

#### DD' Groups.

Quintets :	Obs.	53, 31, 18, 6, 0 ; 17, 22, 19, 13.
(6)	Comp.	43, 29, 17, 8, 0 ; 19, 22, 20, 15.
Sextets :	Obs.	46, 26, 16, 1, 9 ; 26, 27, 26, 20.
(4)	Comp.	47, 31, 17, 3.5, 11 ; 22, 26, 26, 21.
Septets :	Obs.	50, 36, 18, 0, 20 ; 28, 29, 33, 24.
(1)	Comp.	53, 34, 17, 0, 18 ; 26, 32, 31, 25.

#### DF Groups.

Quintets :	Obs.	54, 39, 33, 22, 13 ; 15, 20, 17, 15 ; 6, 8, 8.
(12)	Comp.	47, 39, 31, 24, 17 ; 17, 21, 20, 17 ; 5, 6, 6.

Full details will be published in the Proceedings of the National Academy of Sciences.

HENRY NORRIS RUSSELL.

Mount Wilson Observatory,  
Pasadena, California,  
April 20.

For the benefit of readers of NATURE interested in the subject, it may be convenient to record here the fact that Prof. Russell's formulæ for the intensity ratios in multiplets agree with those given recently (and clearly independently) by Kronig, *Zeit. für Phys.*, 31, p. 885, published April 14, 1925. The final formulæ of Kronig and Russell differ only in superficial algebraic form; they are based on slightly different types of appeal to the Correspondence Principle. The present letter analyses far more experimental material than Kronig's paper. [EDITOR OF NATURE.]

#### The Positive Electrical Drift in the Air.

THE only reason advanced by Dr. Chree (NATURE, April 11, p. 531) in support of his contention that smoke is responsible for atmospheric electricity in towns, is the fact that atmospheric pollution is worst when the potential gradient is abnormally high.

The conditions under which pollution accumulates—the absence of convection currents—are the same for all variable locally produced constituents of town air.

Of these variables I have indicated those which possess an electric charge, namely the positive gas ions poured out by steam locomotives, as the chief cause. I can find no positive charge on smoke. It possesses the property of discharging positively and negatively charged conductors, due to accompanying ionised air, still noticeable some metres to leeward; hence the potential gradient near chimneys is lowered in that direction.

The potential gradient at my laboratory at Plaistow ranges from 50 to 300 per cent. higher with N.W. winds than with N.E., E., or S.E., due to the presence of Stratford Station and its extensive connexions  $1\frac{1}{2}$  mile distant in the former direction. Smoke pollution as judged by horizontal visibility appears to be much the same in either direction.

The electrical properties of mists and clouds indicate that the natural positive gradient is due to positive gas ions distributed throughout the lower atmosphere—the dominating effect of the artificially produced ions near steam railways being due to their relative nearness to the earth in the neighbourhood of the source.

Country fogs exhibit a very high positive potential at ground level. The gradient is normal a little above the mist. The positive gas ions act as Aitken centres of condensation for water vapour. The positively charged water droplets, simulating the behaviour of Millikan's oil-loaded electrons, settle down in still air, and the potential gradient at the earth's surface increases owing to the inverse square law. On

dispersal of the mist the positive gas ions regain their mobility, and in consequence of mutual repulsion and aqueous convection currents, uniform distribution is re-established.

The positive envelopes attracted to and surrounding isolated negative clouds and their aqueous discharges, when they descend from the electron-charged upper air into the lower atmosphere, afford striking proof of the presence of positive ions in the latter.

The violent fluctuations seen as successive low clouds approach an observer can be interpreted in terms of envelopes and central zones or their precipitates. The unstable electrical systems so formed may result in electrical discharge along the surface of separation in the cloud, or the surface and the earth, according to circumstances.

For purposes of international comparison, all measurements of potential gradient should be excluded when mist, clouds, and locomotive drift are present. They are merely local phenomena.

I believe trustworthy readings are only occasionally obtainable within thirty miles of London, or five miles of a railway line. The Channel or Scilly Isles, or some south-western promontory, might provide a suitable site.

I do not doubt that curves plotted from such restricted data would show a nightly minimum and a daily maximum. If the natural potential is due to photoelectric ionisation of the air, with electronic concentration by diffusion in the outer low pressure regions, and a corresponding accumulation of positive ions in the lower, in a manner somewhat analogous to the diffusion potentials in electrolytes investigated by Nernst in 1889, the cessation of the process, and some recombination at night, and a maximum activity during daylight, are to be expected.

If homogeneity is as important a factor in long range electrical transmission as in acoustical, daylight ionisation may be partly responsible for the superior nightly reception by wireless at distant stations.

WILLIAM C. REYNOLDS.

"Wharfedale," Upminster, Essex,  
April 28.

#### Ultra-violet Radiations and Antirachitic Substances.

IN *Science* (1924, 60, 274) Kugelmass and McQuarrie published a preliminary account of experiments they had carried out which led them to think that substances like cod liver oil which possess antirachitic properties emit ultra-violet light on undergoing a process of auto-oxidation. Their technique was briefly as follows. The cod liver oil was made alkaline with caustic potash, and oxygen was bubbled through; the oxidised oil saturated with oxygen was then placed in a beaker, and over it was placed an air-tight photographic plate-holder made of lead containing a sensitised plate. The plate-holder had let into it two windows, one made of quartz and the other of glass. The face of the plate-holder containing these windows was placed directly over the oxidised oil, which was kept in the dark for twenty-four hours. On development the plate showed an image corresponding to the position of the quartz window. It was concluded that this effect was produced by ultra-violet radiations emitted by the oxidised oil since no image was produced where the glass window had been, and the possibility of direct chemical action was excluded by the plate-holder being air-tight.

Working independently, we have both failed to confirm this work. As Russell (*Proc. Roy. Soc., B*, vol. 80) and others have shown, many substances

undergoing auto-oxidation will cause fogging of a photographic plate directly exposed to the material itself, and it can easily be shown that the reacting substance is a vapour obeying the laws of diffusion, etc. If care be taken to exclude this vapour or gas from coming into direct contact with the plate, no fogging will take place. We conclude, therefore, that either the plate-holders used by Kugelmass and McQuarrie were not gas-tight, or that their results are attributable to the quartz used as a window in their apparatus, for the following reasons.

We have observed that fused silica objects after exposure to ultra-violet light emit a phosphorescence which will fog a plate. Generally we have found that fused silica ware shows this property, and that optically worked articles do not; it being possible that this is due to the inclusion of small bubbles in the fused quartz. We have been privately informed that both Lord Rayleigh and Prof. E. C. C. Baly have previously observed the phenomenon, but but we have not been able to trace any statements about it in the literature.

The phosphorescence is really very remarkable if a piece of fused silica be exposed to the radiations of a quartz mercury vapour lamp for several minutes and then warmed to accelerate the emission in a darkened room. The important point from the point of view of the experiments we are considering is, however, that quartz which has been exposed to ultra-violet light may continue to emit rays capable of fogging a photographic plate after twenty-one days at room temperature.

We think it of interest to direct attention to this property of silica, especially as it seems to provide a possible explanation of the results of Kugelmass and McQuarrie, which we have been quite unable to confirm when we took care to use silica which was not emitting a phosphorescence.

J. C. DRUMMOND.

University College,  
London.

T. A. WEBSTER.

National Institute for  
Medical Research,  
Hampstead.

#### Luminescence of Solid Nitrogen and the Auroral Spectrum.

WITH regard to the statements made by Prof. McLennan in a letter to *NATURE* of January 10, I shall be glad if space can be afforded me for a few remarks.

1. From my first experiments of January 1924 I found that  $N_1$  was a band extending between  $\lambda\lambda$  5525 and 5670, and that this band had some structure. Spectrograms taken with a spectrograph of high dispersion, which I obtained in March of the same year, showed that the  $N_1$  band consisted of three maxima. From my point of view, however, this fact was not regarded as anything essentially new, and the material for accurate wave-length measurements was collected for later treatment. Thus I observed the three maxima of  $N_1$  several months before Prof. McLennan announced the fact at the International Congress of Refrigeration on June 17.

2. The essential point in our discussion is whether Prof. McLennan is right in assuming that each of the three maxima of  $N_1$  is to be regarded as a spectral line with a definite wave-length. With regard to this point, I can refer to my previous publications and to more complete publications which are soon to appear, from which it will be evident that the maxima are moving and that the band  $N_1$  approaches the auroral

line by diminution of the size of the particles. The correctness is also confirmed by a number of experiments recently carried out at the laboratory of Leyden. A preliminary note on some of these results is communicated to the Academy of Science of Amsterdam and to the French Academy of Sciences.

3. My remark in my letter to NATURE of November 15 regarding the experimental arrangement had, of course, no reference to the general equipment of the Toronto laboratory, but only to the special arrangement used for exciting and studying the luminosity from solidified gases, and I directed attention to the experimental arrangement to explain our points of divergence, and of course not on account of those facts on which we agree, such as the structure of the  $N_1$  band from pure, solid nitrogen. So, for example, I thought that in this way I might possibly explain why Prof. McLennan had come to the wrong conclusion, that the  $N_1$  band originated from a gaseous state of nitrogen, and that he had not been able to interpret rightly the luminescence from argon.

4. For a more complete discussion of the nature of the luminescence from solidified gases and its connexion with cosmic phenomena, I must refer to my publications.

L. VEGARD.

Physical Institut, Oslo.

#### The Elimination of Mental Defectives.

IN the May issue of the *Nineteenth Century* Prof. Punnett describes in an interesting way the general scope of the recent advances in genetic research, a subject on which the public certainly need much instructing. He repeats certain figures, however, all doubtless perfectly correct, which were calculated for him by Prof. G. H. Hardy, and on this subject we should like to direct his, and his readers', attention to the comments thereon made by Mr. R. A. Fisher in vol. 16, page 114, of the *Eugenics Review*. If those criticisms are correct, and no arguments to the contrary have been forthcoming, the elimination of the feeble in mind by segregation might, at first at all events, be a far more rapid process than Prof. Punnett's figures would lead us to suppose.

The argument is too long here to be reproduced in full, but I may mention that whilst it is truly said that on certain assumptions it is seen that it would be possible only to reduce the proportion of defectives by segregation or sterilisation from 1 in 1000 to 1 in 10,000 in 68 generations, yet on the same assumptions it can be proved that it could be reduced by more than 17 per cent. in a single generation. Moreover, the assumptions made are very questionable, and a more probable hypothesis indicates that the reduction might be so much as 36 per cent. in a single generation. Prof. Punnett also regards genius as probably a quality dependent on a recessive factor, a conclusion in regard to which doubts may also reasonably be expressed.

LEONARD DARWIN.

The Eugenics Education Society,  
11 Lincoln's Inn Fields,  
London, W.C.2,  
May 19.

#### Exaggerated Resonance.

It is well known that the amplitude of response of a syntonized arrangement to a properly timed periodic stimulus, however feeble, is limited only by friction or resistance or other source of dissipation of energy, and that if the resistance could be reduced to zero the response would be theoretically infinite.

In radio telegraphy the response of a syntonized circuit is already very considerable, and I employ a freely oscillating circuit (which I call an  $N$  circuit) to receive conductive stimulus in a special way from an aerial, and to magnify it until it operates on the grid and filament of a valve. The tuning required is very precise; no reaction or inductive connexion with the aerial is permitted; and alien vibrations can be automatically excluded. The resistance of the  $N$  circuit is kept down by stranded wire and perfect connexions, but hitherto no attempt has been made to reduce the resistance to nearly zero by liquid hydrogen or helium. I imagine that if such a circuit could be cooled to near absolute zero the response would be something astonishing. I am not acquainted with any convenience for trying the experiment in Great Britain, but perhaps Prof. McLennan at Toronto has facilities.

OLIVER LODGE.

#### Quantum Radiation.

IN supplement to my brother's letter in NATURE of May 23, I should like to point out how naturally the radiation formula is obtained, and how inevitably  $RT$ , the average energy of the atom between two emissions, enters into it, on the single assumption that the energy of each individual atom increases at a rate proportional to itself, combined with the recognised fact that energy is radiated in quanta (the quantum being called  $h\nu$ , and being presumably dependent on some arrangement or frequency step inside the atom unknown to me).

Let a quantum be radiated when the individual atomic energy of the right kind attains the value  $E_1$ , and let this energy grow continuously from  $E_0$  to  $E_1$ , its average value between these limits being  $RT$ .

Then, assuming that  $dE/E = kdt$ , where  $k$  is some constant, and  $t$  is the controlling variable whether time or otherwise (probably otherwise), two equations follow, namely:

$$E_1 - E_0 = E_0(e^{kt} - 1) = h\nu$$

$$\text{and} \quad E_1 - E_0 = k \int E dt = k \cdot RT \int dt = RT \cdot kt.$$

Thus  $kt = h\nu/RT$ , and everything follows.

ALFRED LODGE.

#### Huxley's Contributions to the Study of the Invertebrata.

I REGRET to find that in the article on "Huxley's Contributions to the Study of the Invertebrata" in NATURE of May 9, p. 734, I inadvertently did injustice to other naturalists past and present.

Thus I praised Huxley for having seen that Peripatus was an arthropod; but the credit for this conclusion really belongs to the late Prof. Moseley, who made preparations and dissections of this animal which clearly showed its arthropod nature and these he demonstrated to Huxley.

Then I credited to Huxley's insight the view which has been sustained by later embryological research, that the formation of the endoderm by delamination is a secondary modification of its original mode of formation by invagination, and also the view that the development of mesoderm by the outgrowth of masses of cells is a modification of its original mode of formation by enterocœlic pouches.

These two theories adopted by Huxley we owe to the penetration and genius of Sir Ray Lankester.

E. W. MACBRIDE.

The Yeasts: a Chapter in Microscopical Science.<sup>1</sup>

By A. CHASTON CHAPMAN, F.R.S.

THE word "fermentation," from *fervere*, to boil or seethe, was at first applied to all cases of chemical change the cause of which was unknown, and which were accompanied by the formation of large quantities of gas, giving the liquid the appearance of boiling or seething. In its widest sense the word is still occasionally applied to a number of chemical processes in which micro-organisms are the active agents, such, for example, as the souring of milk, the conversion of alcohol into vinegar, the production of butyric acid, and similar processes. In its restricted sense, however, it is applied to the conversion of sugar into (mainly) alcohol and carbon dioxide gas by means of the organism known as yeast.

In 1680 Leeuwenhoek addressed to the Royal Society a communication headed "De Fermento Cerevisiæ," in which he announced that he had discovered that yeast consisted of small ovoid globules. Of these, which he appeared to regard as consisting chiefly of batches of six, he gives several excellent drawings. When we remember the nature of the magnifying apparatus with which he had to work, and that the average diameter of the yeast-cell is only  $\frac{1}{150}$  millimetre ( $\frac{1}{3000}$  in.), it will, I think, be realised that Leeuwenhoek had accomplished a very remarkable feat. He did not, however, push the discovery any further, and in this position, curiously enough, the matter remained for more than a century.

In the year 1814 Kieser, in the course of a paper by Dobereiner, described yeast as consisting of small spherical corpuscles, but this statement does not appear to have attracted attention, and about the year 1837 the microscopical character of yeast was again made the subject of investigation, and the true nature of the yeast organism was definitely and independently discovered by three observers, Cagniard de Latour, Schwann, and Kützing. These observers recognised that yeast is composed of a vast number of small transparent globules which reproduce by budding, and consist of a cell wall with granular contents. A year or two later Schwann appears also to have observed the formation of ascospores. These observers, and Cagniard de Latour in especial, put forward the view that it was owing to the vegetation of these cells that the disengagement of carbon dioxide gas and the formation of alcohol were due.

The microscope having definitely shown yeast to consist of minute living cells—that is to say, of a living organism—it became of high interest and importance to study its life-history, and to ascertain what connexion, if any, there was between the vital functions of the organism and the phenomena of fermentation.

In 1897 Buchner made the very important and interesting observation that the liquid contents of the yeast cell, when added to a fermentable liquid, are able to excite fermentation without the presence of any cells at all. He showed that the production of alcohol and carbon dioxide were the result of the activity of an enzyme secreted by the cell, to which he

gave the name zymase. As in the case of other enzymes, zymase is very sensitive to external conditions, and is also highly selective in respect of its chemical activities. Thus, so far as is known, the hexoses alone, and of these, only four (*d*-glucose, *d*-mannose, *d*-galactose and *d*-fructose) are directly fermentable; and before the fermentation of other sugars, such as maltose and cane sugar, can take place, it is necessary that they should be converted into one or other of these hexoses. This is, in all cases, effected by enzymes which are secreted by the yeast, and it is very interesting to note that certain yeasts, whilst secreting invertase, and therefore capable of fermenting cane sugar, do not secrete maltase, and are therefore incapable of fermenting maltose. Then again, there are a few yeasts which, in addition to secreting invertase and maltase, secrete lactase, and are therefore capable of fermenting milk sugar.

We will now turn for a moment to the consideration of yeast as a living organism. The yeasts, as is well known, belong to the great family of the fungi, and may be described as unicellular fungi, reproducing by budding, and capable also of forming ascospores. This latter function is of importance from the point of view of classification, as it serves to differentiate between what are regarded as the true yeasts and certain other closely allied organisms, such as the *torulæ* and *mycoderma*. In the common process of budding, the bud, which occurs first as a small protuberance on the surface of the cell, quickly increases in size until it has attained roughly the dimensions of the parent-cell, after which it usually becomes detached, leading a separate existence, and reproducing in turn by the same process. It often happens that before the offspring cell has separated from the parent-cell it has itself commenced to bud, and so chains or clusters of connected cells may frequently be seen.

In the second mode of reproduction to which reference is made above, the yeast cell becomes changed into an asc, in which are formed a number of spores which may vary from one to as many as twelve, but is usually from two to four. The conditions which favour this mode of reproduction are the employment of young and vigorous cells, a moist surface, plenty of air, and a suitable temperature, usually about 25° C. The line between budding and ascospore formation is not very sharp, and it often happens that budding and sporulation may be taking place simultaneously. As a general rule the spores are spherical, but in some of the yeasts they have very characteristic forms. It would seem that spore formation is a provision on the part of Nature for securing the persistence of the species under conditions in which active budding is impossible. It appears, at any rate, to play an important part in the hibernation of yeasts, rendering it possible for them to live through the winter in the soil, or on surfaces from which very little nutriment can be extracted.

In addition to reproducing by budding and by ascospore formation, yeasts are capable of reproducing by still a third method, namely, that of true conjugation. In these yeasts, constituting the genus *Zygosaccharomyces*, certain of the cells form, instead of

<sup>1</sup> Abridged from the presidential address delivered to the Royal Microscopical Society on January 21, and published in the Journal of the Society for March 1925

ordinary buds, long beak-like processes. When the "beaks" of two adjacent cells touch one another a union takes place, the tips of the "beaks" disappear, and a tubular connexion is established between the two cells, one or both of which then proceed to produce ascospores. Of these conjugating yeasts a number of different species have been described, and this sexual process in one form or another appears to be much more common than was until recently supposed.

Finally, there is a group of organisms, usually included among the Saccharomycetes, which are capable of reproducing by the process of fission. In these so-called Schizosaccharomycetes the fission of the cell, often accompanied by conjugation, is preceded by the formation of a septum which at once commences to divide into two lamellæ. Budding does not occur, but the cells form spores, usually from two to eight. It will be seen, therefore, that in the great family of the yeasts many types of reproduction are exhibited—from true conjugation (heterogamic and isogamic) in the case of some, through isogamic conjugation of ascospores formed in the same asc, in others, to complete parthenogenesis, as in the case of many of the better known cultivated yeasts. The industrial yeasts, which appear to be entirely asexual, may perhaps be regarded as retrograde forms descended from higher types in which sexuality was quite clearly marked. On this point I do not consider myself qualified to express an opinion.

As may well be supposed, in the case of a group of organisms which, although presenting some very important differences, are yet so closely allied, and in which there are very many transitional forms, a great deal of confusion exists in respect of their classification. The system at present generally adopted is one based upon that suggested by Hansen in 1904, but it is customary to include the Schizosaccharomycetes which he excluded, and there has been, of course, a natural tendency to include a number of subdivisions. The great family of the Saccharomycetes is capable of being subdivided into a number of groups or genera, each of which in turn includes a number of species, considerably more than one hundred of which have been described.

From the foregoing it will have been gathered that the division of the yeasts into more or less well-defined genera has been based almost entirely upon differences in their morphological and physiological characters. For the further differentiation into species it was found necessary, in many cases, to adopt other methods of investigation, such as the behaviour of the yeasts towards certain selected carbohydrates, and observations on the optimum conditions required for the formation of ascospores and of films.

Of the very large number of yeast species known, it may be said at once that only a comparatively few are of industrial importance, and it is customary to divide the various yeast species for technical purposes into the "cultivated" and the "wild" yeasts. The former include brewers' and distillers' yeast in all its varieties—that is to say, yeast which has from the earliest times been used for the production of alcoholic beverages, and has in a sense been cultivated for the purpose. This yeast represents, so far as is known, one species, namely, *Saccharomyces cerevisiæ*, although there are many races and varieties which differ considerably in

certain respects, as, for example, in the rapidity with which they bring about fermentation, the degree of attenuation which they can effect, and the flavour of the finished product.

The "wild" yeasts are yeast which occur wild in Nature, frequently having their habitat on the surface of ripe fruits, and often finding their way into the brewery. Some of these yeasts, such as the wine-yeasts, are capable of fulfilling useful functions; others again are, so far as is known, without effect good or bad; whilst others are industrially pathogenic—that is to say, give rise to products which are unpleasant in respect of flavour or smell, or exhibit some other defect, such as pronounced and persistent turbidity.

The importance of these observations in connexion with industrial fermentation processes may easily be imagined. Prior to the isolation and study of the various yeast species, and to the microscopical control to which it naturally led, industrial fermentations were very largely a matter of chance. Sometimes the results were good, sometimes they were bad, but none could say precisely why. Now all that is changed, and when it is remembered that the industrialist who is concerned with any fermentation process is threatened on all sides by intruding organisms which may have the effect of reducing his yields or spoiling his products, the need for scientific control and for the constant employment of the microscope will be evident.

I now propose to consider briefly the cytology, or, if the expression may be permitted, the anatomy of the yeast cell. For a great many years after yeast had been subjected to microscopical examination, there was much uncertainty as to whether the cell did or did not contain a true nucleus. Although the existence of a nucleus is now well established, there is still some doubt as to the precise nature—to say nothing of the functions—of certain of the internal structures which the microscope reveals. Wager and Peniston, Guilliermond, Fuhrmann, Henneberg, Meyer and others have published important papers dealing with the cytology of the yeast cell, and have shown that it possesses a well-defined and complex internal structure.

In addition to a nucleus with a clearly differentiated structure and a nucleolus, the cell contains cytoplasm, a chondrium, metachromatic granules, a nuclear and other vacuoles, and certain thread-like structures. The cell wall, about which a good deal of uncertainty exists, appears to consist as a rule of a single membrane, and to have a complex chemical composition.

In addition to these elements, which may be regarded to some extent as structural, there exist in the cytoplasm accumulations of materials concerned in the nutrition or metabolism of the cell, such, for example, as glycogen and fat.

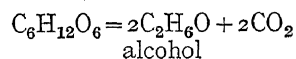
With regard to the functions of these various cell elements it is not yet possible to speak with very great certainty. As in all cells, the nucleus is the main seat, or rather the directing organ, of the physiological functions of the cell. It is all-important in cellular reproduction and division; it plays apparently a prominent part in nutrition, and doubtless in it reside the properties which are hereditary, and in virtue of which one species may be distinguished from another. The chondrium, consisting of two forms of mitochondria, appears to be concerned in processes of nutritional

elaboration, and the nuclear or main vacuole appears to be largely concerned with metabolic processes, and is, according to some observers, the seat of fermentative activity. This latter function has, moreover, been observed to be dependent on the amount of metachromatic granules contained in the cell, the larger the amount of metachromatin (volutin) the greater the fermentative activity; and Henneberg has gone so far as to suggest that the metachromatic granules may be the parent substance from which the enzyme zymase is derived. From this necessarily brief and sketchy account of the yeast-cell anatomy, it will at least be gathered that our knowledge is very imperfect and that we have much to learn, and it may be hoped that expert cytologists may be induced to turn their attention to the elucidation of the subject. There can be very little doubt that the results would be of important industrial as well as of purely biological value.

The ordinary microscopical examination of cells which have been subjected to the drastic processes of fixing and staining obviously has its limitations, and modifications of structure, such as must almost inevitably be brought about by the above processes, may very easily give rise to incorrect conclusions in regard to the internal structure of such a delicate organism as the yeast cell. It would almost appear, in fact, that we have gone as far as it is possible to go in this direction, and some improved method of investigation will have to be resorted to if many of the questions which are at present in doubt are to be satisfactorily solved. It is possible, for example, that a very careful microscopical study of the unstained cell by means of ultra-violet light may be helpful in giving us a better insight into its internal structure, and Mr. Barnard has already carried out some interesting experiments of a preliminary character in this direction.

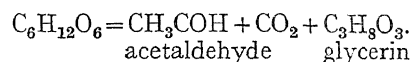
When one remembers that the whole of a miniature solar system is comprised within the compass of an atom, it is not, perhaps, altogether fanciful to suppose that the yeast cell—small as it is—may have a much more highly developed internal organisation than has been revealed with our present imperfect means of investigation, and that there may be more or less distinct localisation of the different functions of the cell. In this connexion two sets of facts may be briefly referred to.

In the first place, it is well known that the yeast cell, like other living organisms, may be made to perform different functions according to the conditions under which it is compelled to carry out its activities. Thus, whilst the ordinary *Saccharomyces cerevisiæ* normally decomposes sugar with the production of alcohol and carbon dioxide, and only about 3 per cent. of glycerin, it has been found that when the fermentation is conducted in the presence of a considerable quantity of sodium sulphite, the main products of the fermentation consist of acetaldehyde and glycerin in roughly equal molecular proportions, and that instead of the normal 3 per cent. so much as 36 per cent. of glycerin can be produced. In other words, it would appear that the well-known equation representing fermentation, namely,



has, when the process is carried out in the presence of

sulphite, to be written in the following very different and unfamiliar form,



In the next place, it is of considerable interest to note that the behaviour of the enzymes within the cell appears to differ materially from that of the same enzymes in the expressed juice. Thus, the acceleration of fermentation by the addition of aldehydes is much greater in the expressed yeast juice than in the case of the living cell, and there are other respects in which the actions proceeding in the juice differ from those occurring within the cell. This seems to suggest that the mechanism of fermentation is in some way directly connected with the organised structure of the cell. In the living cell, again, the velocity of fermentation is much greater than in the expressed juice, and it would seem that, in its natural surroundings within the cell, zymase is free to act without the disturbing influences which probably exist in the expressed juice where all the cell contents are mingled, and some substances may well interfere with the activity of others.

Cramer (Proc. Roy. Soc., 1915, 88, B, 584) has dealt with this important and interesting point, and has shown that the most striking difference between the action of enzymes within the living cells and their action after extraction is the extreme sensitiveness with which, in the former case, they respond to very slight changes in the surrounding medium, being sometimes retarded, sometimes accelerated, and sometimes reversed. According to Cramer, surface tension would appear to be an important factor, such surface tension being operative, for example, at the periphery of the cell and at the boundaries of the nucleus, vacuoles, granules, colloidal aggregates, etc. Thus the conditions for enzyme action may be very different in one part of the cells from those occurring in another part. Under the influence of very slight changes in external conditions there may, for example, take place within the cell a movement of the cytoplasm, or changes in the concentration of the cell constituents which, by altering the surface tension at different parts, may altogether change the conditions for enzymic action.

Even assuming Cramer's explanation to be correct, it still means that the great variations in the physiological and chemical activities of the cell are dependent on internal structure, and it is to this problem that future research may usefully be directed. Any great increase in our knowledge of this subject might prove to be of the highest importance, not merely in regard to industrial operations, but also as affording a deeper insight than we yet possess into the true character of the vital activities of the living cell. The results of such an investigation might well prove to be of fundamental importance. In the living cell we have, in fact, a chemical laboratory of the highest efficiency, and of the most remarkable character; and could we but understand and imitate artificially the processes of building-up and breaking-down which are so quietly and so regularly occurring in a single cell of yeast, we should be not only within measurable distance of a new organic chemistry, but we should also be appreciably nearer to an understanding of that greatest of all problems, the nature of life.

### Dacca: an Experiment in University Education in India.

THE transition phase, now in rapid progress in all matters connected with government in India, has also exercised a profound effect on university education. In many directions experiments have been made during the last few years. Eight new universities have come into being, a number of others are being dis-

Registrar of the University of London, was appointed the first vice-chancellor.

While these decisions were being arrived at, the prospects of a really notable advance in Indian education were most hopeful. A number of suitable buildings, covering nearly a square mile in area, were immediately available. These had been erected, provided with roads and suitably laid out, for the Government of Eastern Bengal and Assam, which came to an end in 1912 on the re-partition of the Provinces of Bengal, Bihar, and Assam. Included in these buildings were the premises of the Dacca College. The area assigned to the University is situated to the north-west of the city of Dacca and alongside the public park of Ramna, and is admirably suited to the needs of a modern residential university. Besides the site and the buildings, a large sum of money, amounting to some 60 lakhs of rupees (about 400,000*l.*), had been set aside by the Government of India for the needs of the new undertaking.

cussed, while in the older institutions, notably Calcutta and Lahore, an effort is being made to raise the standard of teaching, particularly in science. When it is remembered that many of these developments have taken place during a period of acute financial stringency, the strength of the national movement which has given birth to these changes will be evident.

In many respects the new University of Dacca, which was opened on July 1, 1921, is of special significance to those interested in the development of higher education in India. This university owes its foundation to the Calcutta University Commission, presided over by Sir Michael Sadler, and is an attempt to remedy, by means of an actual example, the abuses which had gradually grown up in India round the purely examining bodies of the older type. To many of the present university students in India, collegiate life, such as exists in Europe and the United States, is unknown; there are little or no facilities for sports and other forms of recreation, while the inevitable examinations exercise far too great an influence on the teaching. It was felt by the members of the Sadler Commission that a new university, organised on the model of modern British universities, was essential if any real progress was to be made in higher education in India. Dacca was accordingly selected for the experiment, and one of the members of the Commission, Dr. P. J. Hartog, formerly Academic

Steps were also taken to recruit the very best staff possible, and to make the teaching of science one of the main features of the University. Unfortunately, by the time Dr. Hartog arrived in India in 1920, the financial situation had reached such a position that the Government of Bengal was

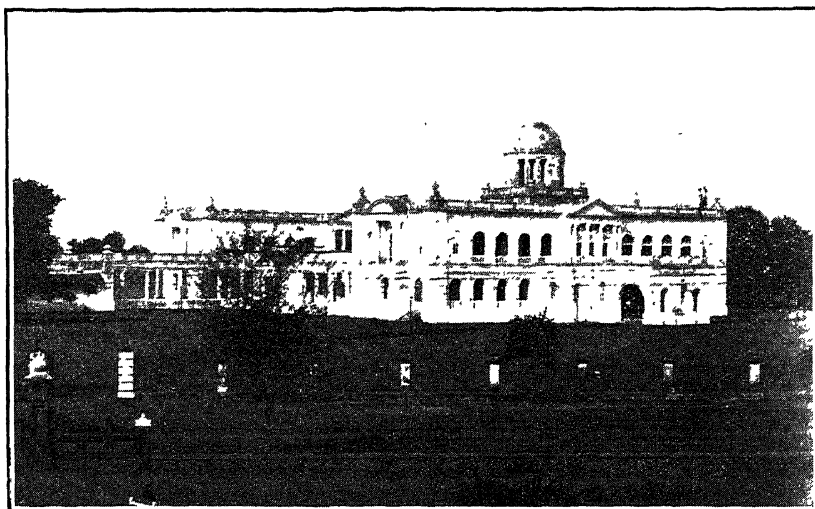


FIG. 1.—University of Dacca. University Court House.

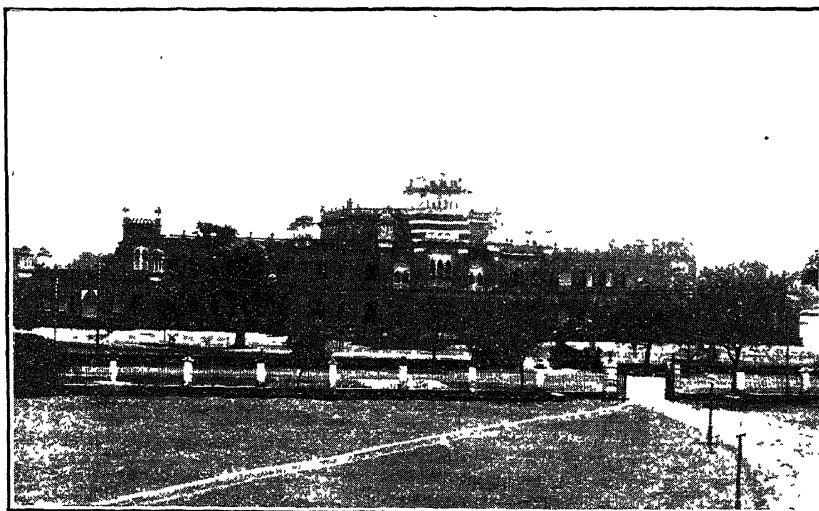


FIG. 2.—University of Dacca. Curzon Hall and Physics Laboratory.

compelled to stop all new developments. An era of severe retrenchment ensued, and the new University found itself sadly crippled. The sixty lakhs found its way into the treasury of the Bengal Government when the Reforms Scheme came into operation. Bengal, however, has admitted the moral claim of the University of Dacca to this sum, and has been releasing it at the rate of four lakhs of rupees a

year for capital in addition to a recurring grant of five lakhs. The total annual income and expenditure of the University are now about seven and a half lakhs of rupees (about 50,000l.).

In spite of the shortage of funds, however, the University came into being in 1921 with nearly a thousand students and every year the numbers have steadily increased. At the present time nearly 1400 students are in residence divided among the three faculties of Arts, Science and Law. The students, other than those who stay with relatives in the town, live in three residential colleges—known as the Dacca Hall, Muslim Hall and Jagannath Hall—round which the social and athletic life of the University mainly centres. Recently, a new and interesting development has taken place as a result of the residential system. Social service organisations, designed for the uplift of the degraded and the enlightenment of the ignorant, have taken firm root in the University and are doing good work.

On the teaching side, Dacca has broken new ground in several directions. A tutorial system has been established, and the students are taught how to use a library. The tutorial class, as designed at Dacca, is intended to counteract the inevitable evils of the examination room. Examination tends to discourage originality. The tutorial system is designed to foster individual effort, to ensure that each student shall be enabled to learn something of intellectual production as well as of reproduction, so that when he enters the world

he will not find himself for the first time confronted with problems to which he had not been taught the answers beforehand. Besides the institution of the tutorial system, the University possesses a good library, the use of which forms an important part of the training of the students. The Sadler Commission in its report stated that in the colleges of some Indian universities, students of university courses read little more than their text-books. This cannot be said of Dacca. The last report shows that 33,982 books were borrowed from the University library during the year. These reforms in the teaching have had their inevitable result. Many of the advanced students have taken up research, and every year a growing number of original papers in languages, history, philosophy, economics, chemistry and physics are being published.

At the Convocation of the University of Dacca on March 6 last, His Excellency Lord Lytton, the Governor of Bengal, in conferring the degree of Doctor of Laws on the vice-chancellor, referred to Dr. Hartog's great services in having successfully established a modern university at Dacca, which though only four years old had already made a name for itself in the world. Lord Lytton stated that the establishment of the tutorial system was largely due to Dr. Hartog, who had worked with patience, with courage, and with industry, and their reward was the appreciation of all his colleagues. They greatly regretted that that would be the last Convocation at which they would see him as their vice-chancellor.

### Obituary.

PROF. ALBIN HALLER, FOR. MEM. R.S.

ALBIN HALLER was born on March 7, 1849, the eldest of a family of eleven children, at Feller-ingen, a small village in the Vosges, near Mulhouse. His father was a master carpenter and cabinet-maker, and his mother carried on a small hardware business. In due course he entered his father's workshop as an apprentice, but two years later, and as the result of a conference between his father and a pharmacist of the neighbourhood, young Haller left his native village and became a student in a pharmacy at Münster; his new master, Achille Gault, undertook the literary as well as the scientific education of his pupil, and later installed him with his brother, Léon Gault, a pharmacist at Colmar.

Thanks to the wise counsels and benevolent interest of these two pharmacists, Haller was able to pass his bachelor of science examinations at Strassburg in May 1870. He volunteered at the outbreak of the war of 1870, was assigned to the army medical service, and was drafted to a hospital at Lyons. The close of hostilities found Haller in a difficult position; his father died, and his mother, left with a large family, decided to open a small hotel in order to set her eldest son free to continue his training; whilst the mother thus became a German subject, the son remained a Frenchman, and rejoined his first teacher, Achille Gault, in a pharmacy at Nancy. When the staff of the University of Strassburg was transferred to Nancy in 1872, he became a student in the School of Pharmacy,

and was awarded his diploma as a pharmacist in 1873.

The training of a pharmacist in France often led, and still often leads, to a career in pure chemistry; this arises from the excellent chemical education given to the French pharmacist. Further, the fact that Alsace was the seat of many flourishing chemical industries had already attracted to chemistry many young Alsacians such as Wurtz, Friedel, Schutzenberger and Ch. Lauth. Haller's tastes and his many talents impelled him to forsake pharmacy and to devote himself to chemical science; he soon became well known as a chemical investigator, and took his degree of doctor of science at Paris in 1879. He was appointed professor of chemistry at Nancy in 1885, and professor of organic chemistry in 1898; in 1899 he succeeded Friedel in the chair of organic chemistry at the Sorbonne, a position which he retained until his retirement last year under the age limit.

During the 'seventies of last century our chemical knowledge of camphor was but slight, partly because of the comparatively small number of camphor derivatives known; Haller attached himself particularly to the problems relating to this ketone and prepared large numbers of new derivatives. His first work related to the behaviour of sodiocamphor, and he was the first to prepare iodocamphor and cyanocamphor; the latter compound led to many new derivatives, such as homocamphoric acid, the study of which threw light on the constitution of camphor itself. He made an exhaustive

study of the condensation products of camphor with aldehydes and ketones, and gave an elegant method of preparing sodiocamphor by the aid of sodamide; he effected the partial synthesis of camphor from camphoric acid, and characterised the isomeric borneols. His study of cyanocamphor led him to investigate the remarkable behaviour of the cyano-derivatives of carboxylic esters and ketones in general, and enabled him to provide a new synthesis of acetonedicarboxylic ester and of citric acid. He published important series of papers on the phthaleins, the anthrones, the indanones and the synthesis of anthracene derivatives; he introduced the idea that the alcohols could act upon esters in the presence of hydrogen chloride in the same way that water acts, and showed that the reaction leads to an exchange of the hydrocarbon radicle in the ester. He carried out a large amount of work on optical rotatory power and refraction constants of organic compounds.

Whilst Haller was a prolific contributor to organic chemistry, he was also an ardent worker in the cause of technical education in France; he recognised both the necessity for stimulating the scientific industries of his country and the hindrance to progress imposed by the tendency towards centralising higher scientific effort in Paris. Thanks largely to his efforts, the Chemical Institute at Nancy was founded, and in due course chairs in industrial chemistry and in tinctorial chemistry were instituted; this was the first of many similar institutions in France. During the war of 1914-1918 Haller acted as president of the French Explosives Committee, and, in this office and in many other directions, his incessant activity and his wide experience rendered invaluable service.

Haller was possessed of great charm of manner; his kindly courtesy, his modest bearing and his fine presence, coupled with the keen interest which he took in the work of his junior colleagues, endeared him to all who had the honour of his friendship. Like so many men of the same age and from the same province, his life had been saddened; he was an Alsatian who felt keenly the loss of his native land in 1870, and he had suffered family losses in the last war. The many honours which came to him could not obliterate these sad remembrances. He died on May 1 from influenza, following upon an accident in the laboratory.

Haller was a Grand Officer of the Legion of Honour; in 1900 he was elected a member of the French Academy of Sciences, and in 1923 became its president. He was well known in England, and had received honorary doctorates in the Universities of Leeds and Cambridge; he was awarded the Davy Medal of the Royal Society in 1917, and was elected a foreign member in 1921. He served several periods as president of the French Chemical Society, and was elected an honorary member of the English Chemical Society in 1908.

WM. J. POPE.

#### MR. H. LING ROTH.

MR. H. LING ROTH, whose death on May 12 will be widely regretted, was born on February 3, 1855, and was a son of Dr. Mathias Roth, of Harley Street, London. He was educated at University College School and studied natural science and philosophy in Germany. Prior to going to Halifax in 1888, he had travelled extensively. He was engaged in business, but

devoted the whole of his spare time to his studies. About twenty-four years ago he voluntarily undertook the work of superintending the Bankfield Museum, Halifax; about twelve years later he was appointed as half-time Keeper, and afterwards he gave his whole time to the Museum. When he first undertook the superintendence of the Museum, it, like other local museums of that time, was in a chaotic condition, but any one who has visited the Museum from time to time cannot but have been struck by the improvements which he made. It is now a model local museum. In particular it illustrates the growth of Halifax and possesses a remarkable series of appliances illustrating the development of the textile industries. The specimens are carefully chosen, well arranged, and most admirably labelled, so that the Museum is a teaching institution of prime importance. Not only has Mr. Ling Roth given time, knowledge, and skill to the Museum, but he has also enriched it with many donations.

By the death of Mr. Ling Roth the science of ethnography loses a student who has not received the recognition that was due to him. This was mainly owing to his quiet, unassuming disposition, and to the fact that he was not connected with a university or large public institution. His work was characterised by painstaking accuracy, and he had a *flair* for collecting specimens to illustrate the particular subject he had in hand. He was a master of the art of collating information and of presenting scattered records in a readable form, which has been of great use to his fellow-students, but in addition, by his own investigations, he has added considerably to ethnographical knowledge. Most of his memoirs and papers have been enriched by his clever draughtsmanship; his drawings bring out just those details which are essential, and thus really illustrate his theme.

The range of Mr. Ling Roth's interests is shown by the following imperfect list of some of his writings: "Crozet's Voyage to Tasmania, New Zealand, etc.," 1891; "The Natives of Sarawak and British North Borneo," 2 vols., 1896; "The Aborigines of Tasmania," London, 1890, 2nd ed. Halifax, 1899; "Great Benin: its Customs, Art and Horrors," Halifax, 1903; "The Genesis of Banking in Halifax," Halifax, 1914; "The Discovery and Settlement of Port Mackay, Queensland," Halifax, 1908; "Oriental Silverwork: Malay and Chinese," 1910; "The Yorkshire Coiners, 1767-1783, with Notes on Old and Prehistoric Halifax," Halifax, 1906; "Sketches and Reminiscences from Queensland, Russia and elsewhere," 1916; "The Maori Mantle," 1923.

Among numerous papers published by the Royal Anthropological Institute may be noted those on the origin of agriculture, salutations, the significance of the couvade, various memoirs on tattooing in Polynesia, Tierra del Fuego, and Tunis, and American quillwork. The series of articles in the Bankfield Museum Notes is of particular interest, among which may be noted the Fijian and Burmese collections; trading in early days; hand wool combing; hand card making; oriental steelyards and bismars; Bishop Blaise, saint, martyr, and woolcombers' patron; and the very valuable series on primitive looms from all parts of the world, which has been reprinted in a separate volume.

A. C. HADDON.

MR. R. B. SEAGER.

WE much regret to announce the death of Mr. Richard B. Seager, the well-known American archaeologist and explorer. According to a message from Sir Arthur Evans in the *Times* of May 14, Mr. Seager was taken ill suddenly while on the voyage from Egypt to Crete. He was landed unconscious at Candia, and died soon afterwards on May 12. Mr. Seager's achievements as an archaeologist won for him a high place in studies connected with the Eastern Mediterranean, and he is probably to be regarded as one of, if not the most, distinguished of the archaeologists from the United States who have been connected with the work of the American School at Athens. His excavations in Eastern Crete led to a series of discoveries which revealed much fresh material bearing on the earliest culture of the island, and afforded evidence of the state of the arts, as well as of the technology and artistic characteristics of the jewelry, lapidary work, etc., in that early phase of the development of Cretan civilisation.

In his telegram, Sir Arthur Evans alludes to the remarkable *fleur* which inspired Mr. Seager's excavations in Eastern Crete. This will be admitted by all who have any knowledge of his work; but he gave ample evidence in his publications that he possessed a sound judgment which, in a sense, was no less remarkable. His published work included three substantial records of his excavations. The first, describing his excavations at Pseira in Crete, was published at Philadelphia in 1910. This was followed by an account

of his excavations at Mochlos, published by the American School in 1912, while in 1916 he published a report on his work at the Cemetery of Pachyammos, Crete, as one of the Anthropological Publications of the University of Pennsylvania. Mr. Seager's personal character and charm won for him many friends, by whom his loss is deeply mourned.

A MESSAGE from the Beirut correspondent of the *Times* announces the deaths, in a motor-car accident, of Dr. N. V. C. Lothian, Dr. Samuel Darling, and Mlle. Besson, members of the League of Nations Malaria Committee. During the War, Dr. Lothian was Deputy-Assistant Director of Medical Services in the Near East, where he was employed mainly on anti-malarial work, and since then he has been with the League of Nations. Dr. Darling was connected with the Rockefeller Foundation for medical research.

WE regret to announce the following deaths:

M. Stanislas Meunier, honorary professor in the National Museum of Natural History, Paris, and author of numerous works on the earth, comparative and experimental geology and on meteorites, aged eighty-one.

Dr. G. L. Spenser, chemist to the Cuban-American Sugar Co. since 1906, and formerly chief of the Sugar Laboratory of the U.S. Bureau of Chemistry, on March 23, aged sixty-six.

### Current Topics and Events.

IN replying to the debate initiated by Lord Olivier in the House of Lords on May 20, on certain questions of land and labour policy in Kenya Colony, Lord Balfour, the Lord President of the Council, took occasion to make an announcement of the highest importance, going far beyond the particular problems of Kenya. After referring to the chapter on research in the report of the Ormsby-Gore Commission on East Africa, Lord Balfour pointed out that "what we want is some machinery by which the larger problems which we now see are presented to us by this vast area in East Africa, and other problems from other parts of our Empire may be more conveniently considered in their entirety." He went on to say: "His Majesty's Government are of the opinion that some institution bearing some resemblance to the Committee of Imperial Defence might be set up for dealing with the purely civilian problems which are becoming more and more insistent in connexion with imperial development."

FROM statements made by Lord Balfour and Mr. Baldwin, the Prime Minister, it appears that the Government has decided to set up a Committee of Imperial Research comparable with the Committee of Imperial Defence. This new body will not only be an instrument for acquiring new and needed knowledge, but it will also act as a clearing house of information and as a central co-ordinating organisation, in connexion with the larger problems—economic, racial, scientific—affecting the whole Empire and on

the solution of which the future development of the Empire must depend. Like the Committee of Imperial Defence, the new institution will perform no executive action of itself; it will be the direct creation of the Prime Minister; it will advise the Cabinet and provide the machinery for examining problems with which there is at present no departmental method of dealing. That, in the barest outline, is the Government scheme.

IT is obvious that a step of first-class importance has been taken and that the potentialities for good of the Committee of Imperial Research can scarcely be exaggerated. What has been done and is to be done is something far greater than to add a mere annexe to the structure of the Department of Scientific and Industrial Research. Already, as was pointed out in a leading article in *NATURE* on November 15, 1924, the work of that department has made a good beginning in the evolution of a national scientific policy. The creation of the Committee of Imperial Research is the first necessary step in the development of an imperial scientific policy—imperial in that it is to take into view the needs of the whole Empire; scientific in its widest sense, embracing, not merely the application of all branches of science, as needed, to the varying problems presented by the different parts of the Empire, but also the methods and outlook of science. If from the start the members of this new Committee take a wide view and a far horizon, it may well turn out that more will be done

for imperial unity and imperial development than has been or can be done by the best laid political or military schemes. The announcement of the names of the members of the Committee of Imperial Research will be awaited with anxious interest.

IN the House of Commons on May 15, Mr. H. Williams asked the Financial Secretary to the Treasury for a statement of the total sum provided for scientific research of all kinds in the estimates for the present financial year. Mr. Guinness replied as follows: "Including the cost of buildings maintained by the Office of Works, but exclusive of the cost of administrative staff (except in the case of the Department of Scientific and Industrial Research), it may be stated that a sum of 4,045,000*l.* is provided in Estimates 1925-26 for scientific research of all kinds." No doubt this figure is accurate, but unless some indication is given as to what is included by the Treasury under the terms "scientific research of all kinds," Mr. Guinness's answer is liable to give a seriously misleading impression.

LET us turn to the Civil Service Estimates for the year ending March 31, 1926, Class IV. (H.M.S.O., Price 1*s.* 6*d.* net). There we find under the section devoted to the Department of Scientific and Industrial Research, that the estimate for the year of that Department, including the Geological Survey of Great Britain, the Museum of Geology, and a Grant in Aid, is 380,263*l.* Of this sum, 40,000*l.* is definitely allocated to "Grants for investigation and research." Estimates for the cost of actual research work, exclusive of the Geological Survey side, reach a total of 355,184*l.*, and against this is set 117,619*l.* as the estimate for Appropriations in Aid, comprised of fees for tests, charges for investigations, sale of maps, of by-products, and so on. These figures cover the work of the National Physical Laboratory, and the official work on building, fuel, and other research. Turning now to the Medical Research Council, another body with which the term "scientific research" is definitely associated, we find that the Grant in Aid of the expenses of the Council is 135,000*l.* Scientific societies, observatories, and so on, account for a further 65,187*l.*, though a large part of this cannot obviously be for scientific research as rightly understood. Our total now is well over half a million, but there is a big gap between this and four millions. The Fighting Services expend a considerable amount upon scientific work of various kinds, which is presumably included in this total, but details as to how the sum is made up would be illuminating. Mr. Guinness's reply requires considerable amplification before it can show anything of the real financial position of scientific research in Great Britain.

A DINNER was given at Christ's College, Cambridge, on Saturday, May 23, in celebration of the attainment by Dr. A. C. Haddon of his seventieth birthday, and on the eve of his retirement from the post of reader in anthropology and ethnology in the University. The chair was taken by Sir William Ridgeway. Among the large gathering present were Mrs. Haddon, the Vice-Chancellor (Prof. A. C. Seward), Sir Arthur

Shipley, Prof. C. G. Seligman, Mr. H. Balfour, Prof. A. Francis Dixon, Prof. J. Graham Kerr, Prof. Hobson, Dr. C. S. Myers, Prof. Pearson, Mr. Martin White, and Mr. P. A. de Laszlo. Eloquent tributes were paid to Dr. Haddon's achievements as an anthropologist and as a teacher of anthropology. Sir William Ridgeway said that his researches in the field had made him one of the leading ethnologists of the day with a world-wide reputation. By his zeal and self-sacrifice he had done more than any man to forward the teaching of anthropology in the University. Mr. Balfour referred to his versatility; he had not been a specialist in any one branch, but was master of them all. Prof. Seligman spoke of his success as a leader of expeditions in the field. In replying, Dr. Haddon referred to the unvarying kindness he had met from his colleagues. In reviewing his life, he said his work as professor of zoology at Dublin had led to his expedition to the Torres Straits, where he had got to know the natives and had turned to study them. Though warned by Sir William Flower that there was no money in his studies—a fact he had afterwards verified—he had persevered, lecturing at Cambridge without stipend until his second expedition to the Torres Straits. In the University, anthropology is still going through critical times and the subject is not yet fully established. Portraits of Dr. Haddon have been painted by Mr. de Laszlo to perpetuate his work. Of these, one will be hung in Christ's College, another is to be given to the Museum, and the third will be presented by the artist to the family.

THE bird sanctuaries in the Royal Parks in London owe their existence in the first instance to the War, for when the gardeners were away, certain enclosures used by them became overgrown with nettles and brambles. In these several kinds of birds, which on migration usually make but a short stay, found suitable cover and remained to build their nests and rear their young. Mr. Rudge Harding sent a note to the *Field* recording the nesting of the willow warbler and the lesser whitethroat in Hyde Park, and Mr. Harold Russell, who saw this, wrote to the Office of Works and suggested the formation of bird sanctuaries. Lord Crawford, then H.M. First Commissioner of Works, appointed a Bird Sanctuary Committee, with Sir Lionel Earle as chairman, and Mr. E. Batch as secretary, and sanctuaries were made in Hyde Park, Kensington Gardens, St. James's Park, and Greenwich Park, in which suitable undergrowth was planted and bird boxes were put up. The experiment continues to be successful. It is on the south side of the bird sanctuary in Hyde Park, which lies just north of the line joining the Superintendent's Lodge and the Powder Magazine, that the memorial to W. H. Hudson has been recently erected. A good many years ago, when Sir Schomberg MacDonnell was the Secretary to the Office of Works, nesting boxes were put up in Hyde Park and Kensington Gardens and Richmond Park at the request of the Selborne Society, which provided the boxes. The results in this case were also satisfactory, and in Richmond Park the first record was obtained of a woodpecker building in a nesting box in Great Britain. In this

park, where there are a heronry and considerable enclosures, the protection of birds has apparently been continued from the time of the first experiment, and received an additional impetus when the other sanctuaries were formed.

THE forthcoming celebration of the centenary of the discovery of benzene (*NATURE*, May 9, p. 685) will, it is hoped, interest and stimulate all who realise the value of science to the community. Though most famous as a physicist, Faraday was also a great chemist; moreover, he was a true natural philosopher, taking a wide and impartial view of things, and his character as a man was singularly beautiful. On June 16, 1825, he communicated to the Royal Society a paper entitled "On new compounds of carbon and hydrogen, and on certain other products obtained during the decomposition of oil by heat," in which he described the isolation and the properties of benzene and butylene (called by him, respectively, "bi-carburet of hydrogen" and "new carburet of hydrogen"), and this paper was referred to by Berzelius as incontestably the most important of the year. The raw material used was the oil which separated during the storage under pressure of the illuminating gas of that period (made by decomposing fish-oil at a red heat), and the hydrocarbons mentioned were extracted by purely physical processes, namely, fractional distillation and "freezing-out." The benzene obtained was substantially pure, containing 11 576 parts of carbon to 1 of hydrogen, as compared with 12 : 1 required by theory.

GREAT skill and patience were shown by Faraday in the discovery of benzene, but it was left to the future to disclose the great importance of the discovery. Not only has benzene played a leading part in the development of the theoretical foundations of organic chemistry, as a solvent and as a starting-point for the preparation of innumerable organic compounds in the laboratory, but it has become an indispensable raw material of industry. It is the parent substance of a host of dyestuffs and medicaments, and it is used in large quantities in the rubber, paint and varnish, vegetable-oil, and motor-fuel industries. As previously announced, the commemoration of the centenary of its discovery will include a reception, lecture, and a dinner. The reception will be held at 11 A.M. in the Royal Institution on June 16, when the following foreign delegates, among others, will be present: Prof. G. Bertrand (Paris), Prof. E. Cohen (Utrecht), Prof. F. Swarts (Ghent), and Prof. J. F. Norris, of the Massachusetts Institute of Technology. Sir William Pope will deliver the lecture at the Institution on Friday evening, June 12, at 9 P.M., on "Faraday as a Chemist." The centenary banquet will take place on the evening of June 16 at the Goldsmiths' Hall. Application for tickets of admission and for the banquet (two guineas) should be made to the Secretary, Royal Institution.

A SEVERE earthquake occurred at about 11 A.M. (about 2 A.M., G.M.T.) on May 23 on the north-west side of Japan. The towns most seriously affected are Kunihamu, Kinosaki and Toyooka, and, as in

1923, the damage was more due to the subsequent fires than to the shocks. A first estimate puts the number of persons killed at 100, and of wounded at 1000, while 10,000 are said to be destitute. The railway services were suspended for a few hours, but rescue trains were not delayed. The shock was strongly felt at Kobe and Osaka on the opposite side of the island, and it was also perceptible at Kyoto, Okayama, Nagoya and Niigata, but not so far as Tokyo. One of the most interesting features of the earthquake is its occurrence on the Japan Sea side of the islands, which is much less frequently visited than the opposite coast. For example, of the ten most extensive and violent earthquakes since the fifth century, three have occurred in central Japan and seven off the south-east coast. On the Japan Sea side, during the same interval, five earthquakes were followed by small sea-waves; on the other side, great sea-waves swept in after twenty-three earthquakes. Again, during the years 1885-1905, according to the late Prof. Omori, 257 earthquakes disturbed areas of more than 25,000 square miles; and, of these, 145 originated off the east coast, and only 9 off the west side. The provinces (Tango and Tajima) chiefly affected by the shock of May 23 seem to have been disturbed by few earthquakes between the years 416 and 1867. In Sekiya's great catalogue, the province of Tajima is only once mentioned (in 1666) as the central district of an earthquake.

ON May 21, 1825, a hundred years ago, the Royal Society of Arts voted its large silver medal and a sum of thirty guineas to William Sturgeon for a number of pieces of apparatus for demonstrating the principles of electromagnetism, which he had presented to the Society. Among this apparatus was a horseshoe magnet made of a piece of round bar iron wound with some eighteen turns of copper wire. Sturgeon was the first to make such an electromagnet. To mark the hundredth anniversary of the presentation, Prof. J. A. Fleming on May 20 delivered a lecture to the Society on "William Sturgeon and the Centenary of the Electromagnet." In the course of the lecture, Prof. Fleming gave a few details of Sturgeon and also dealt with modern theories of magnetism and with the various important alloys which have magnetic properties. Among these is permalloy, which has very large permeability for very small magnetic forces and is being used for the uniform loading of the latest submarine cables, thus increasing the working capacity enormously. Permalloy consists of 78.5 per cent. nickel and 21.5 per cent. iron, and its preparation was due to the research work of two American companies. A section of the new cable is exhibited in the Science Museum, South Kensington. All Sturgeon's original apparatus has unfortunately been lost, but Prof. Fleming showed a replica of the electromagnet.

WHETHER we consider Sturgeon's upbringing, his station in life, or the state of scientific teaching at the time, his career was surprising. The son of an ingenious but idle bootmaker, Sturgeon was apprenticed

to a harsh master and then changed the cobbler's bench for the drill ground, passing from the Militia into the Artillery. With little help he learnt mathematics, Latin, and Greek, and on Woolwich Common made electrical experiments with kites. Leaving the army in 1820 on a pension of a shilling a day, he resumed his cobbling and his scientific experiments, and his merits led to his appointment as lecturer in science at the East India Company's College at Addiscombe. He was forty-two when he made his electromagnet. Later, he was connected with the Adelaide Gallery of Practical Science in the Strand and with the Victoria Gallery of Science at Manchester, but neither institution flourished, and his last years were spent in poverty. He started periodicals and continued to lecture, but found it hard to keep the wolf from the door. When sixty-two years of age he was given a small Civil List pension. No man more deserved such help, but he only enjoyed his pension for a short while, for he died in 1850. At the close of the lecture Prof. Fleming suggested that Sturgeon's work might be fittingly commemorated by the Royal Society of Arts by the foundation of a Sturgeon lecture.

DR. THORNE M. CARPENTER, in his discourse on Friday, May 22, at the Royal Institution on the Nutrition Laboratory of the Carnegie Institution of Washington, said that the greater portion of the researches of the Laboratory are conducted with humans, supplemented by studies on other animals. The development of apparatus for the direct measurement of heat elimination and production and for the determination of respiratory exchange has formed an important part of its work. Recent apparatus includes a gas analysis apparatus for the exact determination of carbon dioxide and oxygen in atmospheric and room air, and a modification of the simplest form of respiratory exchange apparatus so that the indirect determination of the heat of combustion or energy value of foods can be estimated indirectly by the measurement of the oxygen used in the combustion. A comparison of measurements of heat elimination and production by the direct method (calorimetry) and by the indirect method (respiratory exchange) has shown that the indirect method is the most practicable for the determination of basal metabolism. The observations on humans made by Prof. Francis G. Benedict, the Director, and his collaborators have resulted in establishing standards by means of which the normal basal heat production of humans from birth to old age can be predicted. These standards include factors for weight, height, age and sex, and their application in clinical medicine to diagnosis and the effect of treatment, illustrates how a purely abstract scientific study proves of practical value. Examples of recent special researches are the determination of the neuromuscular effect of ethyl alcohol correlated with concentration of alcohol in blood and urine, the metabolism of alcohol, lævulose, and dextrose when injected rectally, and the metabolism of steers, together with the composition of their excreta, as affected by prolonged fasting.

NO. 2900, VOL. 115]

DR. J. S. BOLTON, professor of mental diseases in the University of Leeds, delivered the Maudsley Lecture before the Medico-Psychological Association of Great Britain and Ireland on Thursday, May 21, taking as his subject "Mind and Brain." In the first part of his address, Prof. Bolton discussed the evidence for the possession of mind by the lower animals, and criticised very severely the "anthropisation" of insects and birds. He declared that they obey instincts blindly and that their seeming wisdom is a mere illusion. Purposive action begins to appear with the mammals, but even among humans, intelligence is still in a very primitive state. "Fortunately for us, our recent origin, and the highly plastic state of our constituent parts which we inherit from our pre-human mammalian ancestry, will in the long run prove our salvation by enabling us rapidly to evolve from our present relatively infantile stage of mental development." In Prof. Bolton's opinion, "personality is the intellectual element of mind or cerebral function which exists in inverse proportion to the instinctive element common to mammals and to animals below them." The purpose of education is to replace instinctive reaction to environment by reasoned action, and that this end is not always achieved "is no reason for the retrograde enthroning of the basal instincts which serves as the foundation stone of Freudian psychology." Prof. Bolton later referred to what he termed "the myth of the unconscious mind," a conception based on Freud's theory of dream-interpretation. If it exists, it must be fully formed before even the necessary brain structure for such functions evolves. Prof. Bolton finds it impossible to frame a definition of the unconscious mind which is consistent with the theories of mind and brain he upholds.

ON Thursday, May 21, Capt. Amundsen set out on his flight to the North Pole from King's Bay, Spitsbergen. He proposed to journey along the coast for an hour and then, provided the two "flying-boats" were behaving satisfactorily, he would turn directly to the Pole. It was thought that the actual flight to the Pole would take seven or eight hours, and if the weather conditions were suitable, a stay of twenty-four hours would be made at the Pole for the purpose of making observations. Amundsen was thus due back during Saturday, but at the time of going to press, no news had been received of him. Fine weather appears to have prevailed over the Polar basin during the week-end, but it is feared that the good spell was breaking up. Capt. Amundsen is using two Dornier "Wal" flying boats and is accompanied by Mr. L. Ellsworth, Lieut. Dietrichsen (in charge of the second machine), Lieut. Riiser-Larsen, and Lieut. Omdhal. Both machines are carrying complete equipment, so that in the event of a breakdown, the party will be able to make its way on foot back to the base.

ON behalf of the Field Museum of Natural History, Chicago, Colonel Theodore Roosevelt, junr., and Mr. Kermit Roosevelt are leading an expedition, in other respects financed by Mr. James Simpson, through

central and southern Asia. Entering India at Bombay, the expedition will proceed to Srinagar in Kashmir. Thence crossing the Himalayas by way of Leh and the Karakoram Pass, it will make excursions into the Pamir region and then cross Turkestan to the Thian Shan Mountains. The duration and subsequent course of the expedition will depend on circumstances. The main object of the expedition is to obtain animals of different ages and sexes required for large habitat groups in the Field Museum, but no doubt collections will also be made with a more purely scientific object. It is intended, for example, to collect reptiles, amphibians, and freshwater fishes. Mr. George K. Cherrie will accompany the expedition from the United States, but other trained zoological collectors will be engaged in England or in India.

THE annual visitation of the Royal Observatory, Greenwich, will take place on Saturday, June 6. The Observatory will be open for inspection at 3 P.M.

PROF. W. MAGNUS, of Utrecht, will deliver the Croonian Lecture of the Royal Society on June 11, taking as his subject "Animal Posture."

MR. T. SHEPPARD, the curator of the museums at Hull, has received an intimation from Mr. J. Digby Firth, president of the Leeds Co-operative Field Naturalists' Club, one of the oldest field clubs in Yorkshire, that he has been elected an honorary life member in appreciation of the valuable work he has done and is doing to the cause of science, particularly in the north of England.

IN reply to a question in the House of Commons on May 25, Mr. Baldwin said: "In view of the decision to hold a general inquiry into the broadcasting system towards the close of the year, the Government have decided not to proceed this session with the Wireless Telegraphy and Signalling Bill. A short Bill will be introduced instead, with the single object of resolving any doubt as to the validity of the existing licence system."

DR. N. L. BRITTON, emeritus professor of botany in Columbia University and Director-in-Chief of the New York Botanic Garden; Prof. G. H. Parker, professor of zoology in Harvard University; Prof. F. Raffaele, professor of zoology in the Royal University of Rome; Prof. C. Shröter, professor of botany in the Federal Polytechnic, Zürich; and A. Zahlbruckner, of the botanical department of the State Natural History Museum, Vienna, have been elected foreign members of the Linnean Society of London.

THE following have been elected foreign members of the National Academy of Sciences, Washington, D.C.: The Hon Sir Charles Parsons; Prof. A. S. Eddington, Plumian professor of astronomy and experimental philosophy in the University of Cambridge; Dr. Adolph Engler, professor of botany in the University of Berlin; Dr. Niels Bohr, professor of physics in the University of Copenhagen; M. Charles P. E. Schneider, a distinguished French engineer; Dr. Hans Speman, professor of zoology, University of Freiburg i. Br.

THE Pontificia Accademia Delle Scienze Nuovi Lincei at Rome organised this year, as two years ago, an "Academy Week" of lectures by members of the Academy, as part of a scheme for the spread of knowledge among scientific workers. The lectures were given in the historic halls of the Palazzo della Cancelleria and were much appreciated by the members of the University and the public. The following topics were discussed: History of mathematics (Prof. Gomes Teixeira, University of Oporto); aerodynamics and aeronautical constructions (Prof. Panetti, Royal Polytechnic School of Turin); graphic calculation and mechanical calculation (Prof. M. d'Ocagne, free academician of the Paris Academy of Sciences); geophysics (P. Algué, Director of the Central Observatory of the Philippine Islands); our knowledge of the ultra-microbes (Prof. Caronia, Director of the Clinical Surgery of the University of Rome). The lectures will be published in the Atti of the Papal Academy.

THE second Indian Plant Breeders' Conference was held at Surat on February 26-28, under the chairmanship of Mr. R. K. Bhide, Crop Botanist of the Bombay Presidency. The mere fact that such a conference, attended as it was by a dozen specialists and about twenty others, should be held in India, shows how rapidly that country is now moving along the path of scientific progress. Among the subjects discussed were probable error in field experiments, the problems of sterility and fertilisation, acclimatisation, stability of the performance of improved varieties, and standardisation of testing methods. The general opinion with regard to improved varieties was that they retain their superiority even under the conditions supplied by the ordinary cultivator. The Conference thought it desirable that the Director of Agriculture should get some one on the staff of his Department to specialise in biomathematics, to give lectures to men taking up plant breeding, and so to assist the plant breeders in interpreting their results.

THE National Physical Laboratory is distributing free copies of a useful pamphlet on the testing of weights and balances. It contains information on the conditions which weights intended for accurate work should satisfy, and describes a new form of certificate on a "weight in air" basis, which will secure an accuracy in weighing of one part in a million, in terms of either the International kilogram or of the Imperial standard pound. Balances are also tested as to general functioning and sensitiveness under various loads, and specific gravity balances of the sinker weighing type to an accuracy of one part in a thousand or in three thousand. Tables of fees for the various types of test are given.

IN a paper read to the Society of Engineers on May 4, R. C. S. Walters described some of the water-power exhibits at the British Empire Exhibition at Wembley in 1924 and gave some interesting data. An estimate is made of the fraction of their total water-power resources that several of the dominions have developed. Canada, which has immense resources, utilises 8 per cent. of them; Newfoundland, 30 per cent.; New Zealand (North), 20 per cent.;

New Zealand (South), 2 per cent.; Tasmania, 12 per cent.; and Ceylon, 35 per cent. A large part of this work has been done since the War and further large developments are in progress. Many British firms are specialising on hydro-electric equipment so as to be ready to meet the increased demand for this type of machinery. In Newfoundland there is a large water-power scheme in progress capable of being developed to 250,000 H.P., for the manufacture of paper. A hundred horse-power for a day is required to manufacture a ton of paper. At the Exhibition, impulse turbines capable of giving 60,000 H.P. were shown.

WE have received from the Canadian Department of Mines a copy of pamphlet No. 618 on "Fuels and Fuel Testing." The contents consist of six contributions to the subject; the carbonisation of lignite and sub-bituminous coals, survey of Maritime Provinces coals, nature of sulphur in coal and coke from the Maritime Provinces, gasoline survey (1923), the Hartman oil shale retort, and a report on the Ramage process for oil refining.

CATALOGUE No. 12, 1925, of "Old Books and MSS." just issued by W. H. Robinson, 4 Nelson Street, Newcastle-upon-Tyne, is worth obtaining by readers interested in early editions. Among the sections are Old Scientific Books, Voyages and Travels, and Medicine. Many of the works listed are very rare.

DR. SILBERSTEIN referred in his letter published in last week's NATURE, p. 798, to "a *Phil. Mag.* paper (1919)." Sir Oliver Lodge has been kind enough to send us the exact reference, namely, *Phil. Mag.*, February 1920, vol. 39, p. 161. He himself communicated the paper to the *Phil. Mag.*

LIEUT.-COL. E. GOLD informs us that the name of Capt. Wehrle was inadvertently omitted from the list of members of the sub-commission on balloons in the draft minutes of the meeting, and also from the list appearing in NATURE of May 16, p. 782, col. 2, in Lieut.-Col. Gold's article on the International Commission for the Investigation of the Upper Air.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Head of the Electrical Engineering Department of Rutherford Technical College, Newcastle-upon-Tyne—Director of Education, Education Office, Northumberland Road, Newcastle-upon-Tyne (June 8). A full-time lecturer in mathematics at the Wigan and District Mining and Technical College—The Principal, Library Street, Wigan (June 8). An assistant lecturer in mathematics and an assistant lecturer in geography in the University of Bristol—The Registrar (June 10). An assistant lecturer in biology at King's College for Women (Household and Social Science Department)—The Secretary, Campden Hill Road, W. 8 (June 12). A responsible science mistress (physics and chemistry) at the County School for Girls, Chatham—The Headmistress. The University professorship of geography at the London School of Economics—The Academic Registrar, University of London, South Kensington, S.W.7 (June 18). An assistant chemist in the Government Laboratories, Federated Malay States—The Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1 (June 30). An assistant Government chemist, Zanzibar—The Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1 (June 30).

### Our Astronomical Column.

RESEARCHES ON CEPHEIDS IN SPIRAL NEBULÆ—The May issue of the *Observatory* contains an interesting summary of Prof. Hubble's paper describing his researches. One is filled with admiration for the skill which must be required in determining periods and approximate light curves of some 80 objects, which at their brightest are fainter than mag. 18, and in many cases are too faint at minimum to appear on the plates. Enough of the light curve has to be traced to determine that the type of variation is Cepheid, since Shapley's relation between absolute magnitude and period applies to these alone. The periods vary from 17 days to 50 days, the corresponding maximum magnitudes being 19.0 and 18.4; on plotting log P and maximum magnitude, a good agreement is found with Shapley's law, the average deviation in M 33 being 0.1 magnitude.

As a proof that the Cepheids are really in the spiral nebulae and not merely projected upon them, considerable areas in the neighbouring sky were explored, without finding any Cepheids.

The presence of perceptible absorption of light by nebulous matter is rendered improbable by the fact that the Cepheids are scattered over large regions of the spirals, and all give fairly accordant values of the distance, which comes out as 285,000 parsecs or 930,000 light years for both M 31 and M 33. Variables have also been found in M 81, M 101 and N.G.C. 2403.

COMETS—Dr W. H. Steavenson found Orkisz's Comet still very conspicuous on May 20. It was easily visible in a small hand telescope, and at least

of magnitude 7.5. A tendency to tail formation was noticed in P.A. 250°.

#### EPHEMERIS OF ORKISZ'S COMET FOR 0<sup>h</sup>.

	R.A.	N. Decl.
May 27.	2 <sup>h</sup> 10 <sup>m</sup> 57 <sup>s</sup>	80° 19'
June 4.	6 13 29	81 43
12.	8 31 18	76 45
20.	9 24 13	70 58

Dr. Steavenson also observed Schain's Comet as follows:

G.M.T.	R.A. 1925.0	N. Decl. 1925.0
May 10 <sup>d</sup> 21 <sup>h</sup> 51.9 <sup>m</sup>	10 <sup>h</sup> 36 <sup>m</sup> 24.82 <sup>s</sup>	4° 23' 13.5"
12 21 53.6	10 34 29.60	4 25 14.3
20 22 22.0	10 27 40.20	4 28 53.7

From the first two observations, Mr. G. Merton has corrected the orbit as follows:

T	1925 Sept. 4.5379 G.M.T.
ω	205° 19.14'
Ω	357 29.66
i	146 43.12
log q	0.62196

#### EPHEMERIS OF SCHAIN'S COMET FOR 0<sup>h</sup>.

	R.A.	N. Decl.
May 26.	10 <sup>h</sup> 24 <sup>m</sup> 14 <sup>s</sup>	4° 29'
30.	10 21 47	4 27
June 3.	10 19 36	4 24
7.	10 17 46	4 19
11.	10 16 11	4 14
15.	10 14 52	4 7

## Research Items.

**AN EGYPTIAN SURVIVAL.**—In *Man* for May, Miss Winifred Blackman suggests an explanation, based on a modern custom, of the purpose of the clay balls found by Prof. Peet at Abydos, by Sir Flinders Petrie at Kahun, and by Prof. Garstang at Reqaqna. When those from Abydos were cut open, two were found to contain fragments of reed and one a square bit of linen cloth. Two from Kahun, when examined in 1916 by the Manchester Museum authorities, were found to contain a tuft of red-brown human hair, apparently infantile. These belonged to the XXth dynasty, while those found by Prof. Peet dated from the Old Kingdom. Further, in the Egypt Exploration Society's account of its excavations in 1921 and 1922, "The City of Akhenaten," Pt. I, p. 66, it is stated that a common object among the finds was a small ball of mud, sometimes stamped with impressions of signet rings, containing a wisp of hair. In the course of researches among the *Fellahin* of Upper Egypt, Miss Blackman found that it is a custom for boys, both Kopts and Moslem, to undergo a ceremonial shaving of the tufts of hair which it is customary to leave on their shaven heads. This operation is performed either at the tomb of a sheikh, or a church if the boy is a Kopt, and the tufts are dedicated to the sheikh or a saint as the case may be. The ceremony is accompanied by a feast. The hair cut off is always buried outside the tomb or mosque, either loose or enclosed in a clay ball. A small piece of the dress of a devotee is sometimes suspended from cords hanging over the catafalque of a sheikh. The pieces of linen found in the clay balls may represent a similar votive offering.

**INDUSTRIAL FATIGUE.**—The Harveian Lecture on "Industrial Fatigue," given on April 23 by Dr. C. S. Myers, appears in the *Lancet* of May 2. Dr. Myers reviews the earliest work on fatigue problems, showing that the tests used, whether of efficiency or fatigability, while interesting in themselves, were chiefly valuable in revealing the complicated nature of fatigue. When an application to industry is required, the theoretical studies of muscular metabolism or of the central nervous system fail to throw light on the output variations of the worker. In recent investigations industrial fatigue has been measured by its direct effects in output. Curves of total output and curves of spoilt work are studied; alterations in the environment are made and the effect of these on the work curve noted. By such means it has been possible to show the effect of improvements in lighting, ventilation, posture, arrangement of time, etc. Diminution in output may result not only from fatigue but also from lack of incentive or boredom or worry. In the majority of cases under present-day conditions, industrial fatigue is not to be reduced by shortening the hours of work but by the avoidance of too long uninterrupted spells of work, by the introduction of rest pauses, by adequate training of the worker, by the abolition of causes of needless resentment, irritation, and worry, etc. Industrial fatigue is too complex, and our knowledge of the physiology of the nervous system too rudimentary, to allow of a definition in physical and chemical terms.

**THE VINE IN VICTORIA.**—In "Problems of the Viticultural Industry" A. V. Lyon has collected in small compass much information with regard to the Australian industry in the irrigated lands of the Murray Valley of Victoria. The more important scientific and technical aspects are set forth, with the results of the research work carried out during

the last four years by various bodies of workers. The processes and problems appertaining to viticulture are dealt with systematically from the establishment of a vineyard onwards, the whole scheme being clearly set out in a detailed table of contents. The points dealt with include the pruning and training of the vine, irrigation, drainage and manuring, fruit drying and the seasonal and routine work in the vineyards. A considerable section of the bulletin is devoted to a survey of the fungus and insect pests of the vine, suggestions for treatment and eradication being made in each case. Black spot (*Manginia* *arbutus*), downy mildew (*Plasmopara viticola*), and spiral (*Plasmopara* *spiralis*) are the most serious fungus diseases, and phylloxera and the lesser dried fruit-moth (*Plodia interpunctella*) are the two insects that cause most concern in the Australian viticultural industry. The bulletin concludes with a review of various problems of general interest, including increase in production, cost of production, irrigation, plant breeding and selection, and pruning, on all of which further research is desirable, as investigations are not at present proceeding at a rate commensurable with the importance of the industry.

**ORIGINS OF UNDERGROUND WATERS.**—Volume 28 of the Bulletin of the Adriatic Society of Natural Sciences (Trieste) contains an interesting and very complete account, by Prof. Guido Timeus, of the various physical, chemical, and biological methods which have been suggested for the investigation of the origins, courses, etc., of underground waters. Full details are given of each method, including the fluorescein method of Prof. Timeus himself, and a description is included of a new procedure which, by the dyeing of strands of de-fatted wool, permits of the certain detection of  $10^{-7}$  milligram of the colouring matter.

**CARBONIFEROUS GONIATITES.**—The zonal characters and distribution of the Carboniferous goniatites of the north of England have been worked out in detail by W. S. Bisat (Proc. Yorks. Geol. Soc., 20, Part 1, 1924, p. 40, pls. i-x). In this region goniatites appear first in the upper part of the Lower Carboniferous (Viséan), and continue through the Millstone Grit into the Lower Coal Measures; the main divisions of these beds are characterised by the appearance in succession of the genera *Prolecanites*, *Goniatites* (s. str.), *Eumorphoceras*, *Homoceras*, *Reticuloceras*, *Gastrioceras*. A full account is given of the species found, illustrated by collotype reproductions of photographs.

**RADIOACTIVITY AND GEOLOGY.**—In the Halley Lecture delivered last year, and now published by the Oxford University Press, Prof. J. Joly has summarised his views on "Radioactivity and the Surface History of the Earth." He shows that if the basaltic layer which forms the ocean floor and underlies the continents is as rich in the radioactive elements as those specimens of it which are available for study, then it must, in the course of some 30 million years, become fused at and below a certain depth. At the present time it is mainly solid, but beneath the continents and under the ocean floor the temperature must be nearly that of liquefaction, so that in time the accumulating radioactive heat will supply the latent heat necessary to change its state. It is supposed that in early Tertiary times widespread liquefaction due to this cause actually occurred. The resulting increase of volume caused the continents to be thrown into a state of tension, while the decreased density of the magma allowed the continents

to sink relatively to the oceans. Tidal forces were meanwhile acting on the crust, causing it to drift to the west in opposition to the direction of the earth's rotation. Specially hot magma from beneath the continents thus came to underlie the oceans to the east, and melting of the ocean floor would then occur until the loss of heat into the ocean itself was sufficiently rapid to bring the process to an end and permit recrystallisation to begin. As solidification would effectively proceed from beneath upwards, the continents would gradually be grounded on a more resistant foundation of newly made rocks and brought to a standstill. The decrease of volume attending this part of the cycle would promote severe compression on the continental margins, and corresponding to the deduction we find the mountains of Eurasia beginning to rise from the Miocene onwards. The latent-heat cycle thus comes to a close at about the present time, leaving the continents at a relatively high level and the interior effectively solid.

**VELOCITY OF UPPER AIR.**—The Meteorological Office, Air Ministry, gives a discussion of "The measurement of upper air wind velocities by observations of artificial clouds," by Mr. C. D. Stewart, in Prof. Notes, Vol. 3, No. 38 (H.M. Stationery Office. Price 9d.). The motion of clouds forms an important part of meteorological work, and the observations are of considerable use for forecasting and other branches of the science. During the War much attention was given to the movement of the upper air in relation to the firing of big guns, but for a time afterwards the observations fell into disuse. The inquiry has now received a fresh impetus, and the present discussion gives details to facilitate the necessary calculations. The principle of the mirror nephoscope is the method used for obtaining velocities of both natural and artificial clouds. For ordinary clouds two horizontal mirrors suitably mounted are used, but for artificial clouds where the height is known, one mirror only is required for the determination of their velocity. The method was originally used for clouds formed by the bursting of shells, but observations have recently been made on clouds liberated from aeroplanes. A tin is filled with stannic chloride, which when mixed with the air forms a dense white cloud. The tin or canister is opened and the liquid is ejected by a simple device which results in the formation of a cloud which lasts for about a quarter of an hour. Observations are believed to be effective to at least the height of 3 miles. The discussion contains diagrams of the Hill mirror and the method of observing.

**THE FORCES CONCERNED IN NUCLEAR COLLISIONS.**—In their paper in the *Physikalische Zeitschrift* of November 15, 1924, Drs. H. Pettersson and G. Kirsch mention that they have obtained some evidence which tends to show that, in the case of aluminium, a colliding  $\alpha$ -particle may unite with the nucleus of the metallic atom, the collision being inelastic. In a paper in the *Arkiv för Matematik, Astronomi och Fysik*, communicated January 14, Dr. Pettersson considers the satellite hypothesis of Rutherford and Chadwick, which supposes that the proton liberated by bombardment with an  $\alpha$ -particle existed in the nucleus as a kind of planet, revolving round the core at some distance from the centre. This implies attraction between like electrified particles at very small distances. Dr. Pettersson thinks that it may not be necessary to assume any such reversal of Coulomb's law, either to explain the constitution of the nucleus or the behaviour of the colliding  $\alpha$ -particle, and directs attention to the fact that a charged particle, brought very near to the

surface of a conducting sphere having a charge of the same sign, is attracted by it owing to electrostatic induction. A displacement of the protons and electrons in the nucleus may take place in a similar manner when the  $\alpha$ -particle gets very close to it, and the force acting on the  $\alpha$ -particle may become attractive. At the same time, the resultant force on a proton at the opposite side of the nucleus due to the other protons, the electrons and the  $\alpha$ -particle may become repulsive, and it will leave the atom.

**THE FLUORESCENCE OF DYE STUFFS IN CONCENTRATED SOLUTIONS.**—It has been shown by Dr. S. J. Wawilow that the fluorescent output of dilute solutions can attain very large absolute values. In the *Zeitschrift für Physik*, March 21, he describes an investigation of the phenomenon observed by Stokes, who found that at high concentrations the fluorescent output was greatly diminished. The distribution curve for the energy of fluorescence was practically unchanged when the concentration was altered, which enabled a simple method of measurement to be used. In the cases examined extinction was observed to commence at a definite concentration  $C_0$ , proceeding from that point according to an exponential law which holds until the fluorescent output is very small, when it begins to fall off more rapidly. The curves of extinction and of electrical conductivity of the same solution show no parallelism, which is against any electrolytic explanation of extinction. It is explained provisionally by regarding the heavy molecules as subjected to Brownian movements, and supposing that, when two such molecules collide, one of which is excited, the energy of excitation may be transferred to the other molecule as kinetic energy, no radiation being given off. The theory is worked out in some detail.

**PURE METHYL ALCOHOL.**—The preparation of pure methyl alcohol is described by H. Hartley and H. R. Raikes in the March issue of the *Journal of the Chemical Society*. The alcohol is dehydrated by fractionating in Hempel columns until its boiling point is constant to within  $0.05^\circ$ . It is then re-fractionated once more, refluxed with aluminium amalgam (3 gm. per litre), and finally distilled at the rate of two drops a second, the first 50 c.c. and the final quarter being rejected. If required for electrochemical work, the alcohol is further fractionated and distilled over copper sulphate, a tin condenser being used. Alcohol with a conductivity of  $0.04 \times 10^{-6}$  r.o. was readily obtained in this way. An improved method of determining the water in methyl alcohol is described.

**ALKALI-CHLORINE PRODUCTS.**—An illustrated article in *Chemistry and Industry* for February 27 and March 6, by D. A. Pritchard and G. E. Gollop, describes the Canadian Salt Company's processes for the manufacture of alkali-chlorine products. Saturated brine is pumped from the wells and purified from magnesium and lime salts by the addition of the calculated quantity of sodium carbonate solution containing a trace of caustic soda, at  $85^\circ$ . The mother liquor is decanted off and fed, at  $85^\circ$ , into electrolytic cells of the Gibbs' type, where it is converted into caustic soda (120 gm. per litre) and chlorine (95 per cent.). The working-up of these products is described in considerable detail. The chlorine is liquefied by the tower system. The gas is passed up through a spray of strong sulphuric acid in a tower; it is then dry enough to be liquefied in iron plant. The manufacture of bleaching powder is also carried out by this company; the methods used, together with recent improvements, are given in full.

Modern Investigations of Mental Imagery.<sup>1</sup>

By Prof. T. H. PEAR.

IT is necessary to distinguish at the outset between several types of revived experience. First there is the *after-sensation* (sometimes called the after-image), which is probably not revived at all but a persistence of the effect of the original stimulus. In vision this phenomenon is familiar to us as the positive after-sensation which reproduces the colour and brightness of the original stimulus, and the negative after-sensation in which the colour and brightness are complementary to those of the stimulus. Equally well-known phenomena are the memory images proper; those revivals of experience which may occur in the form of visual, auditory and other images; in fact there are probably as many types of such imagery as there are types of sensation.

Intermediate between these is the type of image which is the subject of this paper. In the last century it was described by Fechner and called by him the *memory after-image*. Until recently it has been called either by this name or the *primary memory image*. Only lately, however, has it been specially studied and in rather special circumstances.

These studies have been chiefly carried on at Marburg under the direction of C. R. Jaensch. These researches claim to have found certain unique and hitherto unrecognised characteristics of imagery in children. Some of the work has been repeated and the conclusions carefully checked by G. W. Allport of Cambridge. From his article on "Eidetic Imagery" (*British Journal of Psychology*, 15, 1924, 99-120) much of the present summary has been taken.

The modern investigators call the image which they are describing an "eidetic image." It differs from an ordinary visual memory image in many ways. Most common among these is that while in the case of a visual image a former visual perception is merely imagined, in the eidetic image the original object is actually "seen" projected in space. It can be seen particularly well when the eyes are closed in a dark room.

Results show that approximately 60 per cent. of all children between the ages of 10 and 15 are able to produce eidetic images. During adolescence this ability retreats. There seems, however, a considerable probability that a large number of poets and artists are in this respect "grown-up children." If this be true, it explains several puzzling points in con-

nexion with poets' and artists' description of their own imagery.

Characteristics of the eidetic image may be summarised thus:

It is literally and truly "seen."

Attention when observing it is directed outwards.

It is usually localised against any background and is never entirely unlocalised.

Though possessed of an outer character like a true perception, it is always recognised as a distinctly subjective phenomenon. It differs both from the memory image and the after-image by its extraordinary richness in detail. This richness in detail is much less dependent upon the structuration in its contents. (The structuration is observable in an ordinary memory image, when a detail particularly interesting to the observer, acting as a nucleus, tends to collect around itself characteristics depending upon it.) In the eidetic image details are frequently observed which do not appear to have this dependence upon the observer's interest. Children have reported details with extraordinary fidelity; e.g. the length and direction of the lines of shading in a stretch of roadway, details unrelated to any "nucleus" in the original picture.

The eidetic image is unusually persistent and often returns. When it does return its details are often extraordinarily accurate. It may be that the so-called hypnagogic images which appear to many normal people just before falling asleep are of the eidetic type. But apparently the exclusion of borderline and pathological phenomena from this conception of the eidetic image makes it impossible at present to discuss this connexion.

There appears to be little doubt of the importance of the study of this eidetic image both for an understanding of the mentality of the developing individual and for a better comprehension of certain questions connected with literature and art. In the realm of applied art it is not impossible that a knowledge of this type of imagery and its occurrence among adults might be of use in the work of the poster artist. For many posters are seen while the observer is in motion, and their details, therefore, are possibly apprehended after the poster has disappeared from the visual field.

The relation of this work to psychopathology, more particularly to the question of pseudo-hallucinations and the type of mentality subject to them, is of the first importance.

<sup>1</sup> Summary of paper read before the Manchester Literary and Philosophical Society, April 28.

Periodicity in Weather and Solar Phenomena.<sup>1</sup>

ALMOST any series of numbers when plotted shows indications of more or less regular sequences; meteorological statistics are no exception to this rule. These recurrences can be investigated by some method of periodogram analysis, and the result is a periodicity or cycle. There exist, however, certain mathematical criteria which can be applied to the results, and when this is done, it is found that the greater number of meteorological periodicities either vanish or at least become highly suspect. According to orthodox views, a cycle should remain constant in length; if it breaks down for a time, it should reappear at the correct phase, and meteorological periodicities do not often behave in the orthodox fashion. Even solar periodicities suffer from this defect, the well-known eleven-

year sunspot cycle undergoing marked variations in length.

Mr. H. W. Clough attempts to get over the difficulty by considering the wave-length of a periodicity as itself a periodic function. In 1905 he found that the length of the sunspot cycle has a periodicity of about 36 years, the "Bruckner cycle"; this 36-year periodicity, however, is itself not constant, its length varying during a longer cycle, estimated at 300 years. He has now investigated a shorter periodicity in sunspots, pressure and temperature, to which various investigators have assigned lengths ranging from 2.5 to 3.5 years, and he finds that it behaves in the same way, its length averaging 2.33 years and varying from 1.5 to 3.5 years according to its position both in the 11-year cycle and in the 36-year cycle. The material which he employs consists of composite series of temperature (1730-1924) and pressure (1743-1924) in

<sup>1</sup> "A Systematically Varying Periodicity of 2.33 Months in Weather and Solar Phenomena," *Philosophical Magazine Review*, vol. 52, 1924, pp. 421-441.

Europe, temperature in the United States from 1780 and sunspots from 1750. From the monthly data, two 12-month means per year were formed, one centred on January 1 and the other on July 1. These means were plotted and the maxima and minima were picked out from the graphs. They were also studied statistically in various ways, and the first conclusion was reached, that there is real evidence for the recurrence of maxima and minima at an average interval of about 2.5 years.

The strongest part of this evidence is provided by the method of correlation, or rather of contingency, since the coefficients are calculated from the signs of the variations only, irrespective of their magnitude. These coefficients are theoretically the same as those calculated by the full method of correlation, but there is a larger possibility of error due to small accidental variations, and it would have been better to have adopted the full method. Each set of data was correlated with the same data 6, 12, 18, etc., months later, and the coefficients showed maxima after 2.5, 5 and 7.5 to 8 years, with intervening minima; this is clear evidence of the existence of a periodicity of about 2.5 years, and is far more convincing than the periods which are derived graphically.

This point being established, the lengths of successive intervals between maxima and between minima were regarded as "observations," and themselves examined for periodicity. It is shown that the average difference between the lengths of successive intervals is significantly less than would be expected on the basis of a chance distribution, indicating a tendency towards grouping, and other statistical evidence to the same effect is found. The lengths of the intervals were accordingly plotted and smooth curves were drawn showing the variations of length with time; these indicated that the intervals between epochs are generally least near the rainfall maxima of the Brückner cycle. The origin of these variable meteorological cycles is sought in solar conditions, especially in a 2.5-year period in the mean latitude of sunspots, which also varies in length according to its position in the eleven-year sunspot cycle and in the Brückner cycle. The author derives this period graphically (though to the present writer the graph is more bewildering than convincing), and he considers that

the epochs of sunspot latitude fit in well with those of temperature in the United States.

Prof. C. F. Marvin, in a critical discussion, appears to accept the results as sound, and at first sight they appear to be so. Further consideration shows certain objections, which may or may not be valid. The graphical method leaves a certain amount to the judgment of the investigator, and however conscientiously the work may be carried out, there is always a danger that personal bias will weight the result. The method as adopted is unsound for another reason, since the combination of two simple periods of the same amplitude, treated by Clough's method, may also give the appearance of a single period which varies in length systematically. The second difficulty concerns the validity of the data. Both in Europe and the United States the length of the temperature cycle shows a secular increase from nearly two years to more than 2.5 years. This may be real, but it is what one would expect from a progressive increase in the trustworthiness of the data as the stations became more numerous and the observations better.

The author does not give his original data for Europe and North America, so that his conclusions cannot be checked directly. In a later table he gives epochs of maximum and minimum pressure at Batavia, which indicate a variable cycle with an average length of 2.6 years. C. Braak found a pressure cycle at Batavia which runs its course in three or occasionally four years, resulting in a "periodicity" of slightly more than three years. The present writer investigated the Batavia pressures by ordinary harmonic analysis and by the "difference-periodogram"; both methods gave a periodicity of 3.15 years, and he could find no trace of a 2.6-year cycle. This result throws doubt on the corresponding periods for Europe and North America.

To sum up, we know that there are frequent examples of recurrence in meteorological phenomena which suggest relationship to solar cycles, but when they are submitted to exact mathematical analysis, the results are usually negative. We infer that either the phenomena are not real, or their true nature is complex. H. W. Clough adopts the latter view, but the solution which he puts forward is not very plausible, and he does not go far enough towards proving it.

C. E. P. B.

### The Tactile Sensory Reflex.

THE investigation of the physiology of the special senses is fraught with difficulties which do not obtrude themselves to the same extent in the case of the other systems of the body. Whereas in the latter the end result of a stimulus is some objective phenomenon, possibly accompanied by a sensation, in the case of the special senses, the subjective sensation is the main effect produced by the stimulation and the accurate description of his sensations by the subject of an experiment requires both training and intelligence, if fallacies are to be avoided. The method of investigation also is not without importance, and should be capable of producing stimuli of known force if any accurate comparison between the degree of stimulation and the resulting sensation is to be obtained.

The method of investigating the sensation of touch by means of hairs of varying degrees of stiffness, while giving information as to the spots in a given area sensitive to this form of stimulation, is unsatisfactory, since it is difficult to estimate the actual degree of force applied. F. Allen and A. Hollenberg (*Quart. J. Exp. Physiol.*, 1924, vol. 14, p. 351) have applied a method used in investigations on visual and auditory sensations, to the elucidation of further facts

relating to the tactile sensation. A blast of air at a known pressure is interrupted by means of a rotating disc with openings in it and the resulting puffs directed upon the area in which the sense of touch is to be examined, e.g. the palmar surface of the tip of the forefinger. Just as in the case of light, the puffs of air will be fused into a single sensation at a certain rate, which may be described as the critical frequency of percussion. Experiment has shown that there are two fusion points at any given pressure of the air pulsations up to a pressure of about 5.0 cm. of mercury, at which these two points coincide. It is possible that they represent the superficial and deep tactile sensations respectively. The duration of the stimulation at the critical frequency was found to be related to the pressure by the formula  $D = -K \log P + C$ , where  $D$  is the duration of the stimulus,  $P$  the pressure, and  $K$  and  $C$  constants. The minus sign shows that the critical frequency has a higher value, that is, the duration of the stimulus becomes shorter as the pressure rises.

It is of great interest to note that similar expressions relate the duration and intensity of stimulation in the case of both light and sound, when interrupted stimuli are used. The constants are different for the

two fusion points and vary also according to the sensitiveness of the skin: thus a dry skin is less sensitive than one kept moist and supple by a thin film of vaseline. Moreover, although the curves obtained by plotting  $D$  against  $\log P$  are straight lines, they show a change of slope at a certain value of  $P$ , in an opposite direction in the case of the two fusion points, so that they finally intersect. This change of slope occurs also with visual and auditory sensations. As might be expected, fatigue decreases sensitiveness, raising the value of  $D$  for a given  $P$ .

Perhaps the most important point, however, which emerges from this research is the discovery of the opposite process—an enhancement of the tactile sensation, either by fatigue of an adjacent area, or by very light previous stimulation of the actual area under study; it is seen also in a fatigued area when the fatigue has passed off. The process appears to be a reflex effect through the central nervous system; and its existence gives an explanation of the phenomena of itching and tickling. In the former case, scratching relieves the itching, but adjacent areas become more sensitive and the process is transferred to them: this, together with the subsidence of its own fatigue, causes enhancement of the sensitiveness of the original area, and so a vicious circle is set up; in the latter case, the effect is probably due to an enhancement of sensitiveness by means of a light stimulus: a stronger stimulus fails to arouse it. The critical frequency is highest in the case of the tactile sensation, but the actual energy necessary to stimulate is greatest for this sense, being least in the case of light. Thus the effect produced by any tactile stimulus is the resultant of the two processes, a direct fatigue of the area stimulated and the reflex enhancement of its sensitiveness: the latter is only visible if the stimulus is so light that fatigue does not occur, or if time is allowed for the fatigue produced to pass away.

### The Liming and Chalking of Soils.

THE second of a series of conferences arranged by the Rothamsted Experimental Station was held on Friday, May 22, when the subject discussed was the liming and chalking of land. Prof. H. E. Armstrong, vice-chairman of the Lawes Agricultural Trust, presided over a gathering of about sixty people, including landowners, farmers, county advisors and organisers, and representatives of firms interested in the supply of chalk and lime.

The morning session was occupied with papers by Dr. J. A. Voelcker, Dr. J. A. Hanley and Mr. E. M. Crowther. Dr. Voelcker dealt with his pot and field experiments at Woburn, the results of which indicate that lime exercises more benefit than the equivalent quantity of chalk. (A full account of these experiments will shortly be published in the Report of the Woburn Experimental Farm for 1923-24.) Dr. Hanley described the striking effect of applications of chalk on the acid areas of Yorkshire, and Mr. Crowther explained some of the errors inherent in all laboratory methods designed to measure the "lime-requirement" of acid soils. The principal difficulty is that soil acidity is made up of an "intensity" and a "quantity" factor, which, on the close analogy of ordinary acidity, may be regarded as the expression of the degree of dissociation and total titratable acidity respectively. Lime requirement methods endeavour to express these two factors by a single value, and hence to this extent are imperfect.

The afternoon session, at the suggestion of the chairman, was devoted to a discussion of the present economic position of liming and chalking, as the urgent need for this operation on large areas of land is

obvious. Col. Fenwick gave an account of the cost of preparing lime from chalk available on his estate; this works out at 10s. per ton exclusive of interest on capital expended in building the kilns. The operation is economically possible for a large farm where chalk is obtainable on the site and ordinary farm labour available. Mr. Dampier Whetham alluded to the lasting effect of chalking and pointed out that the relative merits of lime and chalk should be carefully considered before any extensive national developments are planned, in order to decide whether available capital should be used for erecting lime-kilns or chalk-grinding mills. This point was also emphasised by later speakers. Mr. Garner, of the Hertfordshire Farm Institute, said that in the case of the large areas of land dangerously near the border line of acidity, he recommended one ton of lime per acre once in a rotation. The cost of this spread over four or five years is not serious. Some discussion arose as to the best time in the rotation for application of lime, and although there were individual preferences, it appeared that any crop was suitable with the obvious exception of potatoes.

Sir John Russell, in winding up the discussion, suggested that the immediate problems were: (1) to decide between the relative merits of lime and chalk; (2) to prepare a survey of areas needing treatment; (3) to supplement the geological maps by a survey of the relative accessibility of known deposits; (4) to decide what percentage of magnesium could be safely allowed in the deposits of magnesium limestone should these be used. The conference expressed its approval of these suggestions and was unanimously of opinion that this urgent problem of soil acidity should be dealt with on a national basis, and that some form of loan or financial assistance to farmers is imperative if remedial measures are to be carried out under present economic conditions.

### University and Educational Intelligence.

CAMBRIDGE.—Mrs. Marshall has offered to the University, towards the expenses of the Marshall Library in Economics, the sum of 250*l.* annually during her lifetime, the profits from the sale of the "Memorials of Alfred Marshall," which is about to be published, and a further sum dependent upon the profits from the sale of her husband's books.

The director of the Rockefeller Foundation has written an important letter to the University, giving to the University freedom to modify the plans with regard to the school of pathology which the Foundation recently endowed, should changed conditions or subsequent experience prove the modifications to be desirable. The terms in which this wise provision is made are worth recording, a clause is added to the deed of gift: "with the understanding that the University will in good faith give a full and complete trial over a period of years to its plan for which these funds are contributed but will not be obligated to continue in perpetuity any particular type of organisation or method of instruction."

The Vice-Chancellor announces the resignation on December 31 next of Dr. J. N. Keynes, Pembroke College, from the office of Registry of the University.

Mr. V. C. Robinson, Gonville and Caius College, has been appointed assistant to the Superintendent of the Museum of Zoology.

The Goldsmith's Company has announced that it is prepared to offer certain senior studentships to the total value of 750*l.* a year for post-graduate study.

EDINBURGH.—At the meeting of the University Court on Monday, May 18, the resignation was

intimated of Mr. William McClelland, lecturer in education, as from September 30, on his appointment to the joint post of professor of education in the University of St. Andrews and director of studies at the St. Andrews and Dundee Training Centre.

Major W. S. Patton, lecturer in zoology (entomology and parasitology), was granted leave of absence until October 1, 1926, in order to take charge, at the request of the Royal Society, of an investigation into kala azar in North China, in conjunction with Dr. Edward Hindle.

Mr. K. P. Brown was appointed lecturer in clinical surgery and Dr. G. Buchanan lecturer in bacteriology.

LONDON.—Dr. E. C. Dodds has been appointed to the University chair of biochemistry tenable at Middlesex Hospital Medical School. Dr. Dodds studied at Middlesex Hospital Medical School and in 1918 was appointed demonstrator in physiology. In 1920 he was appointed assistant in the Bland-Sutton Institute of Pathology, and since 1921 he has been lecturer in biochemistry in the Institute. He obtained the B.Sc. degree by research in physiology in 1922, and his doctorate in 1925. He has published numerous papers, either independently or in collaboration with others, in *Jour. Physiol.*, 1921-24; *Jour. Exp. Path.*, 1921-24; *Lancet*, 1921-25; *B.M.J.*, 1922-24, etc.

The title of emeritus professor of bacteriology in the University has been conferred on Prof. Richard T. Hewlett as from August 1 next, on his retirement from the University chair of bacteriology in consequence of the closing of the Department of Bacteriology and Public Health at King's College. The resignation of Sir Halford Mackinder, University professor of geography at the London School of Economics, as from July 31, is announced.

Birkbeck College will be recognised as a School of the University in the Faculties of Arts and Science for evening and part-time students, for a further period of five years, as from October 1 next.

The following doctorates have been conferred: D.Sc. (*Chemistry*): Mr. R. W. West (Imperial College—Royal College of Science), for a thesis entitled "The Effect of Substituents on the Ease of Formation of, and on the Reactivity of the Bromine Atom in, Halogenated Malonyl Derivatives"; Mr. Thomas Iredale (University College), for a thesis entitled "Adsorption from the Gas Phase at a Liquid-gas Interface, with special reference to the Adsorption of Vapours on a Mercury Surface"; and Mr. W. G. Palmer, for a thesis entitled "The Catalytic Activity of Copper," and other papers, together with two subsidiary contributions. D.Sc. (*Physiology*): Mr. B. Babkin (University College), for a thesis entitled (a) "The Influence of the Blood Supply on the Pancreatic Secretion"; (b) "Note on Reflex Hyperglycaemia." D.Sc. (*Veterinary Pathology*): Mr. A. L. Sheather, for a thesis entitled "The Diagnosis of Bovine Mastitis by Milk Examination," together with eight subsidiary contributions. D.Sc. (*Geography*): Mr. C. B. Fawcett, for a thesis entitled "Provinces of England," together with nineteen subsidiary contributions.

Free public lectures on "Geodesy" will be delivered by Mr. A. R. Hinks at Bedford College for Women, on June 3 and 5, at 5.15. No tickets will be required.

MANCHESTER.—The Senate has authorised the conferment of the degree of Doctor of Science upon Mr. Maurice Copisavow, Mr. Fred Fairbrother, Mr. Edwin Leonard Gill.

OXFORD.—On May 20 the annual Romanes Lecture was delivered by Sir William Bragg. The large audience present listened with appreciation to the

lecturer's lucid exposition of the crystalline state, and followed with keen attention his demonstration, by means of lantern slides and other illustrations, of the way in which the use of the X-rays enables the constitution of the atoms and molecules of which crystals are built up, to become recognisable by our ordinary senses.

PROF. H. WIELAND, of Freiburg-im-Baden, has been invited to succeed Prof. Willstätter in the chair of chemistry at the University of Munich.

PROF. K. FAJANS, of the University of Munich, has been invited to become professor and director of the Institute of Physical Chemistry in the University of Freiburg in succession to Prof. G. Meyer. Prof. Fajans has also been nominated a corresponding member of the Russian Academy of Science.

APPLICATIONS are invited by the Ministry of Agriculture and Fisheries for research scholarships, not exceeding seven in number, in agricultural and veterinary science. The scholarships will each be of the annual value of 200*l.* and tenable for three years. Applications must be received not later than June 30 on form 900/T.G., obtainable from the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1.

The Empire Cotton Growing Corporation proposes to award in July a number of studentships in relation to cotton growing, namely, research studentships and advanced study studentships, each of the value of 250*l.*, plus travelling expenses. Application forms may be had from the Secretary of the Corporation, Millbank House, 2 Wood Street, Millbank, S.W.1. They must be returned by, at latest, June 22.

An award of Ramsay Memorial Fellowships for research in chemistry will be made at the end of June. One Fellowship of the value of 300*l.*, open to graduates of all British universities, and one Fellowship of the same value for Glasgow graduates are offered. Forms of application, which can be obtained from Dr. Walter Seton, secretary of the Ramsay Memorial Fellowship Trust, University College, Gower Street, London, W.C.1, must be returned not later than June 6.

The feeling of the need for a university in the south of England was again to the fore at a meeting, held on Friday, May 22, at the Guildhall, Winchester, and addressed by Mr. Austen Chamberlain, M.P., on behalf of University College, Southampton. For the College to become of university rank a sum of 500,000*l.* is necessary, and the meeting was for the purpose of opening a campaign to raise this sum. In the opinion of Dr. C. G. Montefiore, president of the College, its present 400 full-time students could readily be made 800 so soon as its status is raised. The title suggested for the proposed new university is "The University for Wessex."

THE Society of Merchant Venturers offers for competition fifteen scholarships tenable in the day classes of the Faculty of Engineering of the University of Bristol, which is provided and maintained in the Merchant Venturers' Technical College. Candidates must be not less than 17 years of age and must have matriculated. Ten of the scholarships are restricted to the sons of officers in His Majesty's service who were killed in the War, while one is restricted to a son of a citizen of Bethune who has passed either the B.-és-L. or the B.-és-Sc. examination. A War Memorial Scholarship is also offered with a preference to a candidate who is the son of a former student who lost his life while serving with the forces during the War. Further particulars can be obtained from the Registrar of the Merchant Venturers' Technical College.

## Early Science at Oxford.

May 31, 1687. Mr. Caswel gave in a Table shewing ye difference between Kirching his Ephemeris and ye London Latin Ephemeris for ye present year 1687 Dr. Lister's Book *de cochleis Exoticis* was presented to the Society.

June 1, 1686. A letter from Mr. Flavel, a Physician in Newberry, to Mr. Anderton, was read: wherein he affirms that opening a great dog, before he was quite dead, in one of his kidneys he found a *worm* 16 inches long, and an inch in girth.

June 2, 1685. A Letter (dated May 28th) from Mr. Aston S.R.S. brought newes, that the Councill of ye Royall Society has lately made an order, that such Persons, as are of the Oxford or Dublin Society, and likewise of ye Royall Society, in consideration of the charges they are at in ye places, where they reside, for carrying on the common work (ye discovery of Naturall Science) shall be excused half their weekly payments to the Royall Society, and be accountable to their Secretary only for £1 6s per annum. Which order shews such generous and reall encouragement for the advancement of Learning, that this Society, considering that many of their Members may enjoy the Benefit of it, think themselves very much obliged by it, and accordingly order'd their Secretary to returne their humble thanks to the Royal Society for it.

A Letter from Mr. Cole, dated Bristol May 21. tells us, that the best time to see the severall colours afforded by the Purple-fish with the help of ye Sun is by drying the ting'd cloth in a Morning Sun.

An account of a piece of Watch-work by Mr. Samuel Watson of Coventry was communicated and read, it is a *Moving Ephemeris*.

June 3, 1684. Mr Bernard, and some others of ye Society, gave an account that on ye 27th of May last in ye evening, they tried to discover ye *Spot* in ye *Sun*, which Mr. Flamsteed had observed a month before, and which he conjectured would continue during a second revolution of the Sun; but they could discern nothing, tho they made use of a good telescope, 15 foot long, and ye air was clear.

A letter from Mr. Wheeler was read, concerning ye description of a *watch*, invented by him, that may be so fram'd, as to move upon a declivity without any spring, or any other weight, then what is included in ye body of ye watch, where he also fully, and learnedly, shewed ye reason of its motion, and ye manner how it should be pois'd.

Dr Plott then produc'd a peice of *Natrôn*, or Nitre, found on ye top of a lake in Ægypt, which he observed ye last year to yeild, and melt near ye time of ye rising of ye Nile. He said it did not grow moist in ye thaw, nor all ye winter, but it began to relent three or four dayes agoe, and ye paper it was put in, was now moistened all over; He promised to observe its increase, or decrease of weight, and to give an account of it. Afterwards Dr. Plott read a discourse concerning *Vines*, observing that after ye late great *frost* ye Vines bearing *white* grapes have suffered much more, than those that bear *red*; and consequently seem more tender, especially the white *Muscadine*, which are (some of them) quite dead, but ye *Fron-tinjer*, *Burlake*, and *Rhemsh*, not so; these springing again fresh from ye root, though all ye old branches are dead, and yet none of these have escaped so well as ye red, whose Branches are not dead above half way down but even amongst ye red grapes too, there is a difference.

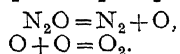
1690. Sir George Mackenzy observ'd that ye highest, and coldest hills in Scotland had ye greatest quantities of Shelly Concretions.

## Societies and Academies.

LONDON.

Royal Society, May 21.—W. E. Curtis and R. G. Long: The structure of the band spectrum of helium. III. The doublet bands. New data extend the main series to the eighth member. Previous difficulties of interpretation are overcome by a non-integral quantum number ( $m - \epsilon$ ). For the earlier bands  $\epsilon$  comes out  $\pm \frac{1}{4}$  within the limits of error, but it departs from this value for the higher members of the series, except in the case of the Q branches, where it remains constant at  $\frac{1}{4}$ . The bands are capable of very accurate representation by the addition of a term  $\beta (m - \epsilon)^4$  to the usual parabolic formula, and this leads to new and much more accurate values of the molecular moments of inertia and separation of the nuclei. This information, in conjunction with deductions concerning the electron orbits, affords support to Lenz's suggestion that the structure of the helium molecule may be related to that of the hydrogen molecule. The results of the analysis of the second series of doublets are closely similar to those obtained from the main series. The two series seem to originate from the same molecule, but a different radiating electron.—G. S. Adair. (1) A critical study of the direct method of measuring the osmotic pressure of proteins. In certain solvents the osmometric observations on hæmoglobin satisfy the three criteria—permanence, reversibility, and reproducibility; therefore they may be regarded as true osmotic pressures. Readings remained constant within 6 per cent. for nine weeks, and no products of protein breakdown could be detected in the outer liquids. With rigorous control of conditions and with adequate criteria for equilibrium, the osmometer method proved thoroughly trustworthy; and when certain corrections were applied it proved capable of giving results accurate to 0.1 mm. of mercury, which corresponds to about one hundred thousandth of a degree in depression of the freezing point. (2) The osmotic pressure of hæmoglobin and the absence of salts. In the theory of hæmoglobin solutions previously accepted, the osmotic pressure of pure hæmoglobin is supposed to be equal to the equivalent 16,700, and it was supposed that traces of salts caused aggregations. Pressures corresponding to the theory were obtained only in the presence of ionising impurities, and it is suggested that the so-called aggregation changes are better explained by the theory that the observed pressure is the sum of the hæmoglobin partial pressure and the partial pressure of undialysed impurities.—J. W. Fisher: Some further experiments on the gyro-magnetic effect. It was sought to detect a gyro-magnetic effect by magnetising a substance (in most cases magnetite) by a rotating magnetic field and looking for a component of magnetisation in a direction perpendicular to the plane of rotation of the field; such a component would be expected to arise if a rotation of the magnetic axes of the molecules is set up by the rotating field. Fields rotating at frequencies of 2 to 5 × 10<sup>4</sup> cycles per second gave no evidence of an effect of this kind even for rotating fields of more than 100 gauss.—G. A. Elliott and I. Masson: Thermal separation in gaseous mixtures. Equilibrium thermal separations have been measured, with nearly constant temperature difference approaching 500° C., for mixtures of hydrogen, helium, and carbon dioxide, taken two at a time and in varying proportions. The results obtained are unexpectedly high. In each case the constituent of higher molecular weight becomes more concentrated in the cold part of the mixture. The greatest separation was obtained from mixtures such that the cold side contained about 55 per cent. of

hydrogen in hydrogen-carbon dioxide, about 60 per cent. of helium in helium-carbon dioxide, and about 60-55 per cent. of helium in hydrogen-helium mixtures. The displacement seems to be specific for helium, whether it is the lighter gas of the pair or not. The separations observed may be attributed almost entirely to mutual intermolecular actions, and not appreciably to differences in the individual thermal expansibilities of the constituents of the gas mixtures.—O. W. Richardson: Structure in the secondary hydrogen spectrum. The paper deals with 10 lines of this spectrum previously classified by Richardson and Tanaka as  $52P(m)$ . These, together with 24 additional lines, are now rearranged as two new  $P$  series, two new  $Q$  series, two new  $R$  series and a fragment each of a  $P$  and  $Q$  series. The  $P$  and  $R$  series have a superficial resemblance to a doublet band. The seven series show four sets of intercombinations. There are abnormalities which show a curious similarity throughout the different sets of term numbers.—C. N. Hinshelwood and C. R. Prichard: The catalytic decomposition of nitrous oxide on the surface of gold. At  $834^{\circ}$ - $990^{\circ}$  C. the surface reaction is unimolecular and is unretarded by oxygen. The gold provides a temporary abode for oxygen atoms, so that the reaction  $2N_2O = 2N_2 + O_2$  can resolve itself into



Probably every molecule of nitrous oxide which strikes the gold wire with a kinetic energy greater than 30,000 calories per gram-molecule gives up its oxygen atom.—E. H. Callow: The velocity of ice crystallisation through supercooled gelatin gels. With "ash-free" gelatin, increase in concentration of gelatin causes decrease in velocity of crystallisation. Such decreases are considerable for concentrations above 1 per cent. (above 2 per cent. at  $P_H$  4.75), e.g. at  $P_H$  1.50 the velocity through a 1 per cent. gel is 960 cm./hr. (about half the velocity through distilled water), and that through a 1.5 per cent. gel is only 40 cm./hr. When the hydrogen-ion concentration is varied by means of hydrochloric acid, the velocity is a minimum near the iso-electric point of gelatin and a maximum about  $P_H$  2.6. Sodium hydroxide increases the velocity. Neutral salt causes a slight increase in velocity of crystallisation through gelatin-water gels, but when sodium chloride is added to gelatin-chloride gels there is a marked decrease in velocity.—R. C. Johnson: Further spectra associated with carbon. The effect of helium on carbon spectra has been investigated in the ultra-violet region. The comet-tail spectrum and a new line spectrum of carbon have been completely measured. The new lines probably constitute the true "arc" spectrum of carbon. No series relationships have, however, been identified. A new band spectrum associated with the comet-tail bands has also been measured and disposed in series. Under the conditions in which the above spectra were produced in helium, the negative band spectrum of carbon was developed with great strength.—W. Sucksmith: The gyromagnetic ratio for magnetite and cobalt.—Ian Sandeman: The secondary spectrum of hydrogen at higher pressures. With the aid of the arc spectrum a band has been selected with head at  $4582.58 \text{ \AA.U.}$  and shading towards the violet. The value of the initial moment of inertia of the molecule emitting the band, when calculated by the aid of the formula of Kramers and Pauli, comes out as  $19.326 \times 10^{-41} \text{ gm. (cm.)}^2$ , agreeing with the value predicted by a static model of triatomic hydrogen,  $H_3$ . The lines of the  $P$ ,  $Q$ , and  $R$  combination discovered by Richardson and Tanaka are also present in the same condition of the arc, and the intensity distribution found for them agrees with that found for the new band.

Mineralogical Society, March 17.—S. Tomkeieff: The structure of aragonite. A new method of etched figures which can be used for the estimation of crystal structure is described. A structure of aragonite, constructed in such a way that the transformation into calcite can be attained with a small expenditure of energy, has been tested by this method. For six of the eight faces examined the spacings are the same as those observed by Sir William Bragg, but the remaining two give only half of the spacings observed. This anomaly is explained by the hypothesis that aragonite in its natural occurrence has undergone a partial transformation into calcite. The structure proposed is unable to explain the intensities of X-ray spectra. Aragonite is considered to be pseudo-orthorhombic.—I. E. Knaggs: Crystalline structure of penta-erythritol tetranitrate. From X-ray examination, the dimensions of the ditetragonal bipyramidal unit cell are  $a = b = 13.2 \text{ \AA.U.}$ ,  $c = 6.66 \text{ \AA.U.}$ , and it contains four molecules, each possessing fourfold symmetry. The crystals are built on the Bravais lattice  $P_1$  and belong to the space-group  $D_{4h}^{17}$ . A structure is proposed in which the molecules have a digonal axis with two planes of symmetry parallel to (100) intersecting in it. There is a considerable departure from the tetrahedral angle of the bonds from the central carbon atom of the molecules. The strain caused thereby, together with the comparative proximity of eight oxygen atoms at intervals in the structure, may contribute to the explosive nature of the compound. The configuration of the nitro-group ( $-\text{NO}_2$ ) is in favour of the oxygen atoms being equivalent.—E. D. Mountain: Potash-oligoclase from Mt. Erebus, South Victoria Land, and anorthoclase from Mt. Kenya, East Africa. Felspar crystals of two types, occurring in the tuffs of Mt. Erebus, have a chemical composition intermediate between anorthoclase and andesine and are referred to potash-oligoclase, being identical with certain rhomb-porphyrty phenocrysts. Similar crystals from Mt. Kenya and Kilima-njaro contain less lime. A complete series of feldspars exists between anorthoclase and andesine having continuously varying properties and mostly of porphyritic occurrence. This necessitates a slight modification in the definition of kenyte, but the limits of the type must depend upon the natural series rather than upon any chemical distinction.—A. Brammall: Further notes on the association of lime with other oxides of RO-type in minerals. Volume-relationships accentuate the differences in chemical behaviour between lime on one hand and magnesia, ferrous oxide, and manganese oxide on the other, and partly control those early molecular associations which promote differentiation in the fluid magma. Particular cases of differentiation in the Dartmoor granite furnish features analogous with those of the anorthosite-peridotite schism, and suggest also that a high concentration of ferrous oxide and magnesia promotes the early separation of orthoclase as phenocrysts, and the zoning of the ground-mass plagioclase.—G. Greenwood: Crystallographic data of some new organic compounds.

Royal Anthropological Institute and the Prehistoric Society of East Anglia (Joint Meeting), April 21.—Mr. Henry Balfour: The status of the Tasmanians among Stone Age peoples. The Tasmanians are probably the only people of whom it can be said with confidence that they remained into quite recent times (to the middle of the last century) in an arrested culture-phase which may be described as strictly palaeolithic. A decided similarity can be indicated between the form and technique of many Tasmanian implements and certain characteristic implements of the Mousterian series. Many of the

types of implements which are particularly characteristic of the Aurignacian culture-horizon are well and abundantly represented in the Tasmanian series. One of the types, which is particularly associated with the Aurignacian division, *i.e.* the "grattoir à museau" of French archæologists, is by far the most abundant of the Tasmanian tools, and it is very significant that the implements within this category exhibit very commonly a flaking technique—a very delicate parallel flaking—which is identical with that which has been specially named "la retouche aurignacienne." The characteristic, more specialised implements of Tasmania, then, suggest a dual analogy—Mousterian and Aurignacian—and if we evaluate the status of this culture in accordance with the highest achievements, we must base our estimate chiefly upon the Aurignacian analogy and promote the Tasmanians to a culture level comparable with that of early late-Palæolithic man. The resemblance is only partial, since several important elements in the culture of Aurignacian man are missing from that of the Tasmanians.—Nina F. Layard: Recent excavations at the neolithic site of Sainte-Gertrude, Holland. Excavations were carried out in October last at the neolithic station of Sainte-Gertrude, Holland, undertaken by the kind permission of M. le Comte René de Geloës, and under the auspices of the Trustees of the Percy Sladen Research Fund. Points of special interest which were observed were the following: Division of labour, suggested by the finding of ateliers specially devoted to the turning out of one type of implement—thus a profusion of picks on one spot, axes on another, and cores found in abundance on a third; the extraordinary number of implements argues either a long occupation or a large number of settlers; the working places were not the living places; the equipment of the miner included picks, axes and racloirs; habits of economy are very noticeable—witness the number of re-fashioned tools. A comparison of the various implements found at Sainte-Gertrude, with those from Cissbury, Grimes' Graves, and other neolithic mining stations, may help in the dating of these English sites.

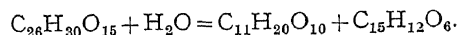
#### MANCHESTER.

Literary and Philosophical Society, March 31.—G. H. Carpenter: Collembola from southern New Zealand. There are species of the widespread genera Pseudachorutes from Mount Algidus, as well as of Paronella which had previously been known across the eastern tropics from West Africa to Queensland. But the most important discoveries are a species of Cryptopygus at Ben More, Canterbury, and two species of Lepidophorella. The former had previously been known from Graham Land and the South Orkneys; the latter from Chile and Patagonia. Their presence in New Zealand and its outlier is most suggestive for comparison with distributional facts derived from the study of other groups which indicate ancient extensions of antarctic and sub-antarctic lands.—F. E. Weiss: On the structure of the leaves of the graft-hybrids, *Cratægo-mespilus Asniersii* and *Cratægo-mespilus Dardari*. It has been a common practice on the continent to graft the medlar (*Mespilus germanica*) on the stem of the hawthorn (*Cratægus monogyna*). In several instances shoots have been produced from near the region of the graft which partook of the nature of both stock and scion. These have been termed graft-hybrids. In the leaves of the two forms discussed, in the former the epidermal cells of the upper surface of the leaves are in surface view

small and more or less straight-walled like those of the hawthorn, and not large and sinuous as in the medlar. The resemblance to the hawthorn may be due to the fact that the leaf is in shape and size more like that of the hawthorn than the medlar. The leaves of *Cratægo-mespilus Dardari*, which are in shape more like those of the medlar though smaller in size, have epidermal cells, intermediate in shape and size between those of the medlar and hawthorn. If these graft-hybrids are periclinal chimæras, their epidermal cells have in the leaves at all events been modified to a great extent by the underlying tissues, with which they are no doubt organically connected by protoplasmic threads.

#### PARIS.

Academy of Sciences, April 20.—Le Prieur: With the De Goys expedition from Paris to Gao. An account of the results obtained with the author's apparatus (which automatically records the path taken by an aeroplane), in two air voyages between Paris and Gao, a distance of 4000 kilometres.—Bertrand Gambier: The surfaces of translation of Sophus Lie.—A. Lafay: A means of modifying the wake of a cylinder moving in a fluid.—B. Hostinsky: The theory of magnetism in movement by Poisson.—F. Baldet: The influence of pressure on the band spectra of carbon in the thermo-electronic bulb. Consequences for the theory of comets. It is shown that the pressure plays an essential part in the existence of the different groups of carbon bands.—Arvid Leide: Researches on the K series of the X-rays. The table given shows the results of the measurements in the zone  $29\text{Cu}-53\text{I}$ .—A. Maubert, L. Jaloustre, and P. Lemay: The influence of radium on the catalase of the liver. As with the bromide of thorium-X, radium in strong doses paralyses while in weak doses it activates the catalase. Radium emanation acts similarly, at least with small doses. The only difference observed between the effects of radium and thorium-X is that the  $\beta$  and  $\gamma$  rays of radium reduce the activity of catalase, an effect not observed in the earlier experiments with thorium-X.—Mlle. Germaine Cauquil: The thermochemical study of the sodium derivatives of cyclohexanol.—Marcel Frèrejacque: The structure of the phenylhydrazones of glucose.—Henry Derville: The facies of the carboniferous limestone in the Boulonnais.—E. F. Gautier and J. Savornin: The red layers of Ouauizert (Central Morocco).—Pierre Le Conte: The regime of the waters of the Channel and the transformation into heat of a fraction of the energy of the tidal currents.—M. Bridel and C. Charaux: The products of the ferment hydrolysis of rhamnicoside: primeverose and rhamnicogenol. The hydrolysis of rhamnicoside by a ferment produces primeverose and rhamnicogenol in accordance with the equation



Rhamnicogenol is a derivative of methylanthranol.—René Jeannel: Apterism in insular insects. The study of Trachinæ in various localities shows only one example which might be interpreted as a case of apterism produced by isolation in an island; this is *T. quadristriatus* in the island of Elba. Other examples from Madeira, the Canaries, Corsica, and Sardinia prove, on the contrary, that the fact of living on an island has no effect in producing disappearance of the wings.—Edouard Chatton and Mme. Chatton: The action of external factors on the Infusoria. The determinism of the formation of chains in Colpidium.—F. Diénert: The purification of water.

## Official Publications Received.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. Edited by W. I. Spear. New Series, No. 22, January. Pp. 234. (London: Institution of Civil Engineers.)

Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 45, Part 1, No. 7: An Investigation of the Absorption of Superposed X-radiations. By Wm. H. Watson. Pp. 43-53. 1s. Vol. 45, Part 1, No. 8: The Stability of Suspensions. (I): The Rate of Sedimentation of Kaolin Suspensions by Salts at varying Hydrogen Ion Concentrations. By William Ogilvy Kermack and William Turner Horace Williamson. Pp. 59-70. 1s. Vol. 45, Part 1, No. 9: The Influence of Gelatin on the Stability of a Colloidal Solution of Cholesterol, and on the Charge on the Particles. By W. I. Kermack and Peter MacCallum. Pp. 71-89. 1s. 6d. Vol. 45, Part 1, No. 10: The Action of Salts with Multivalent Cations on Colloidal Solutions of Gold and Gum Benzoin. By William Ogilvy Kermack and Cecil Innes Bithwell Voge. Pp. 90-101. 1s. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Ministry of Health. Advisory Committee on Water. Report on Measures for the Protection of Underground Water. Pp. 19. (London: H.M. Stationery Office.) 2d. net.

The Physical Society of London. Proceedings, Vol. 37, Part 3, April 15. Pp. 101-194. (London: Fleetway Press, Ltd.) 6s. net.

Proceedings of the Cambridge Philosophical Society. Biological Sciences. Vol. 1, No. 4, April. Pp. 219-277. (Cambridge: At the University Press.) 12s. 6d. net.

Aeronautical Research Committee. Reports and Memoranda. No. 934 (Ae. 155): Wind Channel Tests on Radiators. By R. G. Harris and W. K. Alford. Pp. 16+5 plates. 1s. net. No. 942 (Ae. 162): The Royal Aircraft Establishment Control of Movement Recorder, Mark III. By D. A. Jones and H. L. Stevens. Pp. 8+3 plates. 6d. net. No. 948 (Ae. 163): Tests of three Aerofoils suitable for High Speed; A.D. 1, Sloane, and R.A.F. 26. By F. B. Bradfield and A. S. Hartshorn. Pp. 6+6 plates. 6d. net. No. 944 (Ae. 164): Measurement of Pitching Moments due to Roll on Wings of Avro 504.K. By F. B. Bradfield. Pp. 6+2 plates. 4d. net. No. 945 (Ae. 165): Lift and Drag of Junker Monoplane: Comparison of Model with full scale Results. By H. O. Coombes, P. Coombes, H. Glauert and A. S. Hartshorn. Pp. 10+10 plates. 9d. net. No. 946 (Ae. 166): The Theory of the Design of Aerofoils, with an Analysis of the Experimental Results for the Aerofoils R.A.F. 25, 26, 30 to 38. By H. Glauert. Pp. 7+3 plates. 6d. net. No. 948 (Ae. 168): An Experimental Investigation into the Properties of certain Framed Structures having Rectangular Bracing Members. By Prof. A. J. Sutton Pippard. Pp. 25+6 plates. 1s. 3d. net. (London: H.M. Stationery Office.)

The Volcanic Area and Hot Springs of Lassen Peak. By Arthur L. Day and F. T. Allen. (Publication No. 760.) Pp. 1+10 plates. (Washington: Carnegie Institution.)

Rhodesia Museum, Bulawayo. Twenty-third Annual Report, 1924. Pp. 12. (Bulawayo.)

Field Museum of Natural History. Report Series, Vol. 6, No. 4: Annual Report of the Director to the Board of Trustees for the Year 1924. (Publication 227.) Pp. 265-383+plates 47-62. (Chicago.)

Ministry of Agriculture, Egypt: Technical and Scientific Service (Botanical Section). Bulletin No. 55: Ratoon Cotton in Egypt; a Preliminary Note. By Jarvis Templeton. Pp. iii+14+1 plate. (Cairo: Government Publications Office.) 5 P.T.

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 17: Buildings. By Fletcher B. Dresslar. Pp. ix+100+45 plates. (Washington: Government Printing Office.) 45 cents.

Experimental Researches and Reports published by the Department of the Interior. The Interior Series, No. 7, 1924. Pp. iii+175. (Shetfield.)

The Institute of Physics. Report of the Board for the Year 1924. Pp. 15. (London.)

Bergens Museum, 1925: en historisk fremstilling redigert av professorkollegiet. Pp. 523. (Bergen.)

Nauka Polska: jej potrzeby, Organizacja i Rozwój. Tom 5. Pp. vi+553. (Warszawa: Im. Mianowskiego.)

La science polonaise: ses besoins, son organisation et ses progrès. Résumé. Tome 5. Pp. 553. (Varsovie: J. Mianowski.)

Proceedings of the Royal Irish Academy. Vol. 27, Section A, No. 1: The Equilibrium of Ionisation in the Atmosphere. By Prof. J. J. Nolan, R. K. Boylin and G. P. de Saichy. Pp. 12. 1s. Vol. 27, Section B, Nos. 4, 5: The  $\alpha$  and  $\gamma$  Isomerides of 2,4,6,3',4'-Pentamethoxy Diphenyl Ether. By J. J. Drumm, Norah G. J. O'Reilly and Prof. Hugh Ryan; The Chemistry of Aldehydes with Methyl ethyl ketone, by Prof. Hugh Ryan and J. J. Lennan. Pp. 19-36. 1s. (Dublin: Hodges, Figgis and Co., London: Williams and Norgate, Ltd.)

Bulletin of the American Museum of Natural History. Vol. 51, Art. 9: A Revision of the Mesozoic Crocodilia of North America. By Charles C. Mook. Pp. 319-432+plates 4-5. (New York.)

Memoirs of the Geological Survey of India. Palaeontologia Indica. New Series, Vol. 6, Memoir No. 4: Upper Carboniferous Fossils from Chitral and the Pamirs. By Dr. F. R. Cowper Reed. Pp. vii+134+10 plates. 9.13 rupees; 15s. 3d. New Series, Vol. 8, Memoir No. 2: The Anthracotheriidae of the Dera Bugti Deposits in Baluchistan. By C. Forster Cooper. Pp. iv+60+7 plates. 4 rupees; 6s. 4d. (Calcutta: Government of India Central Publication Branch.)

Memoirs of the Geological Survey of India. Vol. 48, Part 2: The Geology of parts of the Persian Provinces of Fars, Kirman and Laristan. By Dr. Guy E. Pilbeam. Pp. 1+116 plates. 11.16 (Calcutta: Government of India Central Publication Branch.) 3.12 rupees; 6s. 3d.

Survey of India. General Report for 1923-24, from 1st October 1923 to 30th September 1924. Prepared under the Direction of Col. E. A. Tandy. Pp. vii+66+ii+7 maps. (Calcutta.) 2 rupees; 3s. 6d.

Canada. The Dominion Fuel Board in co-operation with the Geological Survey, Department of Mines. Smoky River Coal Field Examination and Comparison with the Kananaskis Area. By James McEvoy. Pp. x+19+5 plates. (Ottawa: F. A. Acland.)

Canada. Department of Mines: Geological Survey. Bulletin No. 39: Colour Printing of Geological Maps. By C.-O. Senécal. (Geological Series No. 44.) Pp. iv+4 plates. (Ottawa: F. A. Acland.)

Report and Balance Sheet of the National Botanic Gardens of South Africa, Kirstenbosch, Newlands, Cape (and the Karoo Garden, Whitehill, near Matjiesfontein), for the Year ending 31st December 1924. Pp. 23. (Kirstenbosch.)

## Diary of Societies.

SATURDAY, MAY 30.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at King's College), at 10 A.M.—R. Chambers and P. Reznikoff: Studies on the Plasma Membrane and Physical State of Protoplasm by Micro-dissection and Micro-injection.—C. Shearer: Child's Hypothesis.—J. S. Huxley: Some Problems of Differential Growth.—Dr. W. H. Pearsall: Rates of Growth and Plant Form.

ROYAL INSTITUTION OF GREAT BRITAIN, at 8.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (II).

MONDAY, JUNE 1.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.

WEDNESDAY, JUNE 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. R. Whiddington: The Passage of Electricity through Vacuum Tubes (Tyndall Lectures) (III).

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—Dr. C. H. Mayo: A Consideration of Gastric and Duodenal Ulcer.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Dr. R. L. Smith-Rose: The Effect of Wave Damping in Radio Direction-finding.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Annual Congress) (at Folkestone) (continued on June 4, 5, 6).—Sir John Russell: The Place of Science in Rural Life (Presidential Address).—A. G. Tansley: The Vegetation of the English Chalk.—A. L. Leach: New Road Sections in North Kent.—E. C. S. Baker: Field Naturalists and Evolution.—G. L. Pepler: Revision of Survey in East Kent.—D. W. Cutler: Life in a Garden.—J. J. Eekersley: Lecture.—Sir Arthur Smith Woodward: The Evolution of Fishes (Evening Lecture).—Capt. J. J. Eekersley: Broadcasting (Evening Lecture).

THURSDAY, JUNE 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. F. O. Bower: The Natural Classification of Ferns as a Study in Evolution (III).

CHEMICAL SOCIETY, at 8.—W. A. Wightman: The Spatial Structure of Crystallites. Part I: A New Aspect of Mohr's Theory and the Structure of Crystallites. By T. A. Henry and H. Paget: Chenopodium. Part II: The Structure of the Carbon Fraction.—J. A. Goodson and Dr. T. A. Henry: Echitamine.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynaecology Section) (Annual General Meeting), at 8.—Dr. A. Willett: Placenta Praevia treated by Traction on the Fore-coming Head.—D. C. L. Fitzwilliams: Curiosities in Connection with the Secretion of Milk.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Annual Congress) (at Folkestone). (See June 3 for programme.)

FRIDAY, JUNE 5.

ROYAL SOCIETY OF MEDICINE (Laryngology Section) (Summer Meeting), at 10 A.M.—Dr. Tapia: The Big Pharyngostomes as an Accident in Laryngectomy: How they can be Avoided and the way of Closing them.—Dr. C. Mayo: Methods of Caring for Diseases of the Pharynx, Larynx, and Mouth.—Dr. R. Rodger: Tracheotomy in Tuberculous Laryngitis.—Dr. A. J. Turner and Dr. F. E. Reynolds: Furuncle of the Cavernous Sinus; Thrombosis the Pathway of Infection.—Dr. J. S. Fraser: Intra-nasal Dacryocystotomy.—At 3.—Clinical Meeting.—Prof. Burger: Pharyngeal Voice in a Case of Complete Laryngectomy.

BRITISH PSYCHOLOGICAL SOCIETY (at University College), at 5.30.—Extraordinary General Meeting.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—W. Worrall: Dictionary Evening.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—A. J. Brill and H. B. Milner: The Geology of the Eastbourne-Hastings Coastline.—G. S. Sweeting: The Geology of the Country around Crowhurst.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Howard Carter: The Tomb of Tut-Ankh-Amen from the Ante-Room to the Burial Chamber.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Annual Congress) (at Folkestone). (See June 3 for programme.)

SATURDAY, JUNE 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (III).

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Annual Congress) (at Folkestone). (See June 3 for programme.)

## FREE PUBLIC LECTURES.

WEDNESDAY, JUNE 3.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—A. R. Hinks: Geodesy. (Succeeding Lecture on June 5.)

THURSDAY, JUNE 4.

St. Mary's Hospital (Institute of Pathology and Research), at 5.—Sir Arthur Keith: The Structural and Functional Disorders of the Great Bowel.



SATURDAY, JUNE 6, 1925.

## CONTENTS.

	PAGE
An Imperial Research Committee . . . . .	861
River Regulation. By Dr. Brysson Cunningham . . . . .	863
Anthropology of African Tribes. By Mrs. Seligman . . . . .	866
Schools of Psycho-Analysis. By M. C. . . . .	867
Our Bookshelf . . . . .	868
Letters to the Editor :	
Ether-drift and the Relativity Theory.—Prof. A. S. Eddington, F.R.S. . . . .	870
The Faraday Benzene Centenary.—Prof. Henry E. Armstrong, F.R.S. . . . .	870
Depth-recording with Plankton-nets.—Rollo Appleyard . . . . .	870
The Origin of Adaptations.—Prof. T. D. A. Cockerell . . . . .	871
The Jet-wave Accelerometer.—Dr. Jul. Hartmann . . . . .	872
The Origin of the Continents.—Dr. Arthur Holmes . . . . .	873
The Cresswell Engravings.—J. Wilfrid Jackson . . . . .	874
Effect of High Tension Electric Fields upon the Discharge of Locomotive Gases.—Dr. P. L. Mercanton . . . . .	874
Intensities in Band Spectra.—G. H. Dieke . . . . .	875
The Word "Australopithecus" and Others.—Prof. Raymond A. Dart . . . . .	875
Photo-electric Cells for Colour-matching.—Sir J. E. Petavel, F.R.S. . . . .	875
The Cooling of the Earth. By Dr. Harold Jeffreys, F.R.S. . . . .	876
The Royal Academy Exhibition . . . . .	878
The University Celebrations at Pavia . . . . .	879
Obituary :—	
Sir William Fletcher Barrett, F.R.S. By Sir Oliver Lodge, F.R.S. . . . .	880
Father A. L. Cortie, S.J. . . . .	881
Current Topics and Events . . . . .	882
Research Items . . . . .	886
The Fat Soluble Vitamins and Irradiation in Nutrition . . . . .	889
Power Alcohol from Root Crops . . . . .	890
The Ascent of Beerenberg, Jan Mayen . . . . .	891
University and Educational Intelligence . . . . .	891
Early Science at Oxford . . . . .	892
Societies and Academies . . . . .	893
Official Publications Received . . . . .	896
Diary of Societies . . . . .	896

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## An Imperial Research Committee.

MOST of Britain's tropical possessions were acquired by accident rather than by design. The home government has never exhibited any particular anxiety to undertake the obvious initial responsibilities of the administration of new territories. It has left to poorly paid local administrative officers the task of meeting expenditure on the essential services out of taxation of the populations committed to their care. The efficiency of these officers is measured by the home authorities, not by the development of the potential resources of a country, not by the happiness, health, and growth of the native populations, not by any enterprise they display in fostering the introduction of new varieties of economic crops, but solely by their success in balancing their budgets. As a general rule, the governors have been "safe" conventional-minded men, unable even in a crisis to stir the home authorities into action.

The result of this attitude of conventional indifference to progress, to the possibilities of the applications of science to the development of the vast potential resources of Nature, is nowhere more strikingly exemplified than in British tropical possessions. After thirty years of British occupation, the agricultural implements principally used by the natives of East Africa are the stick and the hoe. In a country hungry for motor-spirit, the whole of the bye-products of an immense colliery are wasted. In territories where the distances between centres of administration are great, and the difficulties of maintaining telegraph wires are many, no attempt is made to establish wireless communication.

Years elapse before discoveries made in one territory regarding the new treatment of a human disease, yaws, for example, are communicated to the neighbouring administration. Although it appears to be definitely established that the shifting cultivation practised by the native populations, involving as it does the destruction by burning and ring-marking of the primary forests, is responsible for the impoverishment of the soil and the progressive desiccation of Africa, no serious attempt has yet been made to put a stop to the practice of grass-burning. In certain territories, cotton has been introduced and its cultivation fostered, but no adequate safeguards have been taken to prevent the distribution of dirty seed to the natives, with the result that preventable diseases have been introduced. In others, where richer cattle food would vastly improve the quality and efficiency of draught oxen, cotton seed is being burned for fuel at ginneries and molasses from local sugar factories is being wasted, both of which are valuable ingredients in cattle food.

The sudden enthusiasm of an administration for the increase of a particular economic crop might, by restricting the area under food crops, bring about a disastrous famine. This kind of enthusiasm might easily result also in the crops being planted in wholly unsuitable soils. The decision to raise taxes on a commodity might, as in the case of the salt tax in India, result in such a reduced consumption of a vital commodity that the efficiency of the population be greatly reduced.

Many other problems arise in dealing with the native populations. The sudden change in the traditional habits of a tribe, for example, the restriction of their freedom of movement from one site to another, might easily be responsible for an appalling outbreak of disease. Pastoral tribesmen, encouraged to work in factories and mines, are particularly subject to tuberculosis. The incidence of taxation on a tribe which is too remote from the transport system of the country to make the production of economic crops a practical proposition results too frequently in the male members of the tribe being forced to seek work in districts far removed from their homes. This has not only a bad effect on the birth-rate of the tribe, but results also in the introduction of disease on the return of the men to their homes. Even the prevention of tribal warfare is not an unadulterated blessing. The cessation of tribal warfare has led to a marked deterioration in the domestic stock of the natives, due largely to the lack of knowledge of animal husbandry among the natives. Then again, if natives from a grain-eating district migrate in search of work to a district where the natives subsist on ox-blood and milk or bananas, there is a great deal of debility due to digestive troubles.

It can safely be said that these and many other problems and possibilities are only just being realised by the administrations in our various tropical possessions; and we are further from the solution of most of the problems than we are from the appreciation of the possibilities of the economic development of the territories.

The recent announcement, therefore, by the Prime Minister, in a characteristically eloquent speech in which he paid a tribute to the enthusiasm of the late Lord Milner for research, that in appointing the Earl of Balfour as Lord President of the Council he was giving the people of Great Britain an earnest of the intention of the Government to see that the matters of co-operation and co-ordination in scientific work throughout the Empire should be regarded as the first work of a man peculiarly fitted for the responsibility, is particularly welcome. This announcement, moreover, was followed by another by Lord Balfour himself a few days later. In the course of the debate in the House of Lords on Kenya Colony on May 20, the Archbishop of Canterbury, referring to the scientific

chapters of the "brilliant Report" of the East African Commission, pleaded for the "scientific inquiry into all the conditions of climate, soil, fauna, flora and population in all these [East African] areas" as recommended in the Report, and suggested that a certain percentage of the 10,000,000*l.* loan recommended for the development of the transport system of the territories should be "definitely devoted to such preliminary inquiries on a large and really worthy scale by competent men." In replying for the Government, Lord Balfour gave a clearer indication of its intention with regard to Imperial research.

Referring to the Report of the East African Commission, he asked, was it not clear from a study of that document that what was wanted was some machinery by which the larger problems which we now saw were presented to us by the vast area in East Africa, and other problems from other parts of the Empire, could be conveniently considered in their entirety? He stated that the Government is of the opinion that an institution bearing a resemblance to the Committee of Imperial Defence should be set up for dealing with the purely civilian problems which become more and more insistent in connexion with Imperial development. This body is to be the direct creation of the Prime Minister. It will advise the Cabinet, it will provide machinery for examining problems with which there is at present no Departmental method of dealing, and, having examined them and formed an opinion, the Cabinet will then have to decide upon the applicability of its recommendations to the necessities of the case and practical possibilities of carrying them out.

This sudden resolve of the Government, for which the scientific member of the East African Commission, Major Church, must be given no little credit, is made none too soon. The eyes of the civilised world are focussed on the British overseas territories. The attitude of dispossessed Germany and of certain of our commercial rivals is severely critical, and not without justification they consider that we have undertaken vast additional responsibilities with which our existing machinery of government is unable to cope. They consider also that among these responsibilities is that of developing the vast natural resources of the countries in our keeping.

The advantages of an Imperial Research Committee are obvious. Only those who have visited the colonies, and adjacent territories in a tropical country, can fully appreciate the isolation of the scientific workers in those territories, so complete that discoveries or activities in one territory are absolutely unknown in those adjacent to it. Then again, as is clearly indicated in the Ormsby-Gore Report, some administrations have not yet sufficiently understood or formulated their problems

to realise the services which their solution demands. Furthermore, there is no real existing over-riding authority which can effectively enforce the co-operation of the various administrations in a campaign against a common menace, be it tsetse-fly, pink boll-worm, rinderpest, or venereal disease. There are other advantages also. Unless Major Church had been a member of the East African Commission, very few of the local scientific workers would have been given the opportunity to express their views on the problems arising in the development of their respective territories. There is virtually no committee existing at the Colonial Office which acts at all adequately as a liaison and advisory body to colonial scientific officers. Still less is the present Colonial Research Committee in a position on its own initiative to make proposals embodying a research programme to the Secretary of State. It is true that the Imperial Institute does act as a consultative body to the Crown Colonies and some of the British Dominions, and that it gives advice when asked for it. But it is clear that what is envisaged, and what is needed, is an authoritative body which shall be in a position to formulate a policy and programmes for research without waiting necessarily for a stimulus from abroad.

From another point of view the proposal is most gratifying to the general body of men of science. In essence, it is a recognition of the all-important rôle of the scientific worker, not only in the development of the Empire, but also in the life of any community. We may eventually reach the stage in human development when workers in pure and applied science are at the top of the pillar of public esteem, when the fact is appreciated that science rightly used, and the scientific outlook, may not only save us from social disasters and material wants, but also lift us to hitherto unimaginable heights of life and illumination.

If the Imperial Research Committee is formed, and if it fulfils its proper functions, we shall be travelling a stage further along the road of progress. It is essential, therefore, that those of us who guard the interests of science and believe in the worth of scientific knowledge should watch with jealous care the selection of this Committee. We do not hesitate to suggest that included in this august body, charged with such grave responsibilities, should be the member of the East African Commission, to whose labours, in the main, the project is due. The Report of the Commission is made particularly distinctive from our point of view by its treatment of the scientific aspects of the problem of development of the promising territories surveyed, and the spirit of this statement is exactly what is wanted to inspire the work of an Imperial Research Committee.

### River Regulation.

*Regulation of Rivers without Embankments: as Applied in the Training Works at the Headwaters of the Rangoon River, Burma (locally known as the Myitma Training Works).* By F. A. Leete, assisted by G. C. Cheyne. Pp. xii + 122 + 36 plates + 10 maps. (London: Crosby Lockwood and Son, 1924.) 30s. net.

THE practice of the science of river training and regulation is beset by so many difficulties, and success has often to be achieved in the face of obstacles and impediments of so intractable a character, that the suggestion that a river may be left to effect its own training is, at first sight, a little startling. One may even experience a slight feeling of incredulity in glancing at the title of the book forming the subject of this notice, which will be intensified, indeed, when it is found that the author includes within the term "embankments" all artificial aids to bank formation, with the exception of certain sticks of bamboo. At the same time, it must be observed that as the object of training works is to produce embankments of a permanent character, the signification of the word in the title is particular and limited.

Obviously, the title chosen is, in a sense, paradoxical, but the book certainly indicates a novel and ingenious method of river training, which is clearly demonstrated to be of the highest value and utility in the cases in which it has been employed. Before dealing with the limitations of its application, we will briefly describe the method itself.

The scene of the operations described is in Burma, among the headwaters of the Rangoon River. These streams, principally used and, in normal condition, highly serviceable for the transportation of logs of teak from the uplands to the coast, are fed by hillside torrents taking their rise in the range of mountains known as the Pegu Yomas, which form the eastern boundary of the watershed of the river Irrawaddy. These hills have an extreme altitude of about 2500 feet, and they are composed of very friable sandstones and shales. The rainfall varies from 60 to 120 inches, and during the monsoon period, when the precipitation is a maximum, the hill streams come down in high flood at frequent intervals, carrying immense quantities of sand and clay in suspension. Spreading themselves out, on reaching the foot of the hills, in a network of shallow and interlacing channels, the flood waters are dispersed over the plain, submerging the paddy fields and producing a series of swamps and *lahas* (the native term for tracts inundated annually). For log transportation, such a regimen is in the highest degree a source of trouble and expense. Before regulation was undertaken, very few logs found their way to the main

Rangoon River (locally known as the Myitmaka) without assistance; most of them were left stranded in the shallow channels, or scattered over the rice

attempts at regulation. High embankments, successful enough but costly to construct, were succeeded by low embankments, also with satisfactory results, until the



FIG. 1.—Dragging of logs through mud by elephants. From "Regulation of Rivers without Embankments"

fields. Some were lost, others abandoned, and many were only retrieved at considerable labour by dragging them for long distances by means of elephants (Fig. 1).

inspiration came, in 1917, that no artificial embankments at all were necessary. Observing the effect produced on the silt-laden stream by stranded logs

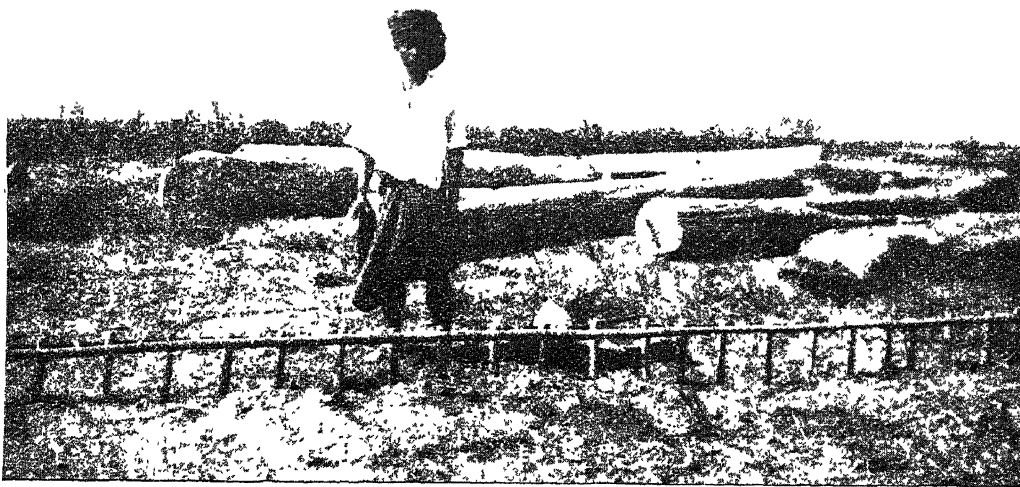


FIG. 2.—Bamboo stake fencing; usual type adopted since 1917. The stakes seen in picture originally stood 3 ft. out of the ground. From "Regulation of Rivers without Embankments."

The condition of affairs appeared to be so hopeless in 1910, that sanction was given to a project for stopping the logs at the railway line and sending them on to Rangoon by rail.

It is superfluous to follow closely the history of the

and other debris, round which deposits accrued, the trial was made of a fencing of bamboo stakes along the desired line of embankment. The result fully justified the expectations which had been formed. The stakes became embedded in deposit, which

gradually accreted to heights ranging up to 9 or 10 feet, or even more. Natural embankments were thus formed, completely defining the channel and keeping the stream within bounds.

For a fuller and precise description of the preliminary measures, we quote Mr. Leete's own words:

"The line along which it is desired to form the new channel is pegged out, and usually follows more or less the natural depression. All jungle growth to a width of 150 feet on each side of the line is cut down flush with the ground, and burned or cleared away. One hundred feet on each side of the line, simple bamboo fences are made. These consist of pointed bamboos, 5 to 6 feet long, driven into the ground about 9 inches

completely embedded in the deposit which forms around them and spreads out over the area on both sides, so that considerable tracts are reclaimed for cultivation. When the first row of stakes are buried, a second row may be driven, but this is not often necessary. The river banks continue to accrete until the stream has formed for itself a channel large enough to contain practically the whole of its normal flood water (Fig. 3).

Although eminently successful under the conditions obtaining in Burma, it obviously does not follow that such training methods are of universal application. There are manifest limitations to their serviceability. They are essentially suitable in the case of streams

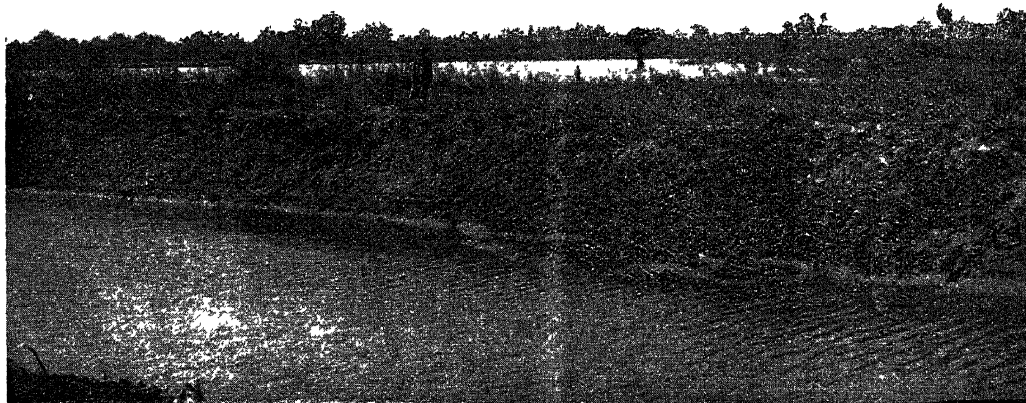


FIG. 3.—Shwele stream. 8 ft. banks only 3 years old. *Laha* water can be seen behind.  
From "Regulation of Rivers without Embankments."

apart, with their tops dressed to a steady slope and about 3 feet above ground level. These stakes are lashed to a horizontal rail, with coir rope, about 6 inches from their tops, to hold them in position (Fig. 2). Where this fence crosses side channels, the bamboos naturally stand higher out of the ground, and must be strutted to withstand the additional pressure at these points. Bad bends are eliminated by short cuts, protected by additional strutted fencing.

"During the early rises . . . the water tends to spread out over the country. It is at this time that the fences do their best work. They catch up the many kinds of small rubbish brought down on every jungle rise, and form a barrier checking the flow of the water. The check to the current causes it to deposit the heavier particles of sand on the stream side of the fence, the finer particles being carried beyond it. In this way, each rise serves to heighten the banks now forming, as well as to raise the level of the surrounding country."

In a very short time it is found that the stakes are

originating as hillside torrents, and heavily charged with detritus and sandy silt; and then, chiefly, in their upper reaches. Considerable variation in water level and frequent overtopping of banks in the early stages are features of the course of channel formation, and when these characteristics are lacking, the method cannot be utilised, or, at any rate, not so effectively or with such striking results.

The process is, however, certainly a notable step in the development of the science of channel training, and further experience in its use will be watched with interest. The volume which we have had under review gives much local information of a helpful character to river engineers desirous of employing the method elsewhere, under conditions similar to those obtaining in Burma. There are ten maps, nine diagrams, and an abundance of photographs.

BRYSSON CUNNINGHAM.

### Anthropology of African Tribes.

- (1) *The Vanishing Tribes of Kenya: a Description of the Manners and Customs of the Primitive and Interesting Tribes dwelling on the Vast Southern Slopes of Mount Kenya, and their Fast Disappearing Native Methods of Life.* By Major G. St. J. Orde Browne. Pp. 284 + 16 plates. (London: Seeley, Service and Co., Ltd., 1925.) 21s. net.
- (2) *On the Trail of the Bushongo: an Account of a Remarkable and hitherto Unknown African People, their Origin, Art, High Social and Political Organisation and Culture, derived from the Author's Personal Experience amongst them.* By E. Torday. Pp. 286 + 16 plates. (London: Seeley, Service and Co., Ltd., 1925.) 21s. net.
- (3) *Fresh Tracks in the Belgian Congo: from the Uganda Border to the Mouth of the Congo.* By Hermann Norden. Pp. 303 + 30 plates + 2 maps. (London: Witherby and Co., 1924.) 18s. net.

THE three books under notice all indicate the extraordinary rate of change that is taking place in Africa. Though Mr. Norden may be inclined to see "a step towards Utopia" in a Belgian industrial plantation, most thoughtful observers are alarmed by the effect of industrialism on black Africa. Mr. Norden noticed that, whereas his belongings had never been pilfered in the wilder parts of the Congo, when he approached "civilisation" locks became necessary. That, of course, is nothing when compared to the break-down of tribal custom and belief, with its accompanying loss of control which follows so quickly on contact with Europeans. Major Orde Browne is acutely aware of this grave danger, so that his book, (1) "The Vanishing Tribes of Kenya," will be of value to all who have to deal with natives either as government officials, missionaries, or settlers. What he has to say on the brideprice, initiation, trial by ordeal and government, is all eminently sound. His book is a careful, though not exhaustive, study of the tribes on the south-east slopes of Mt. Kenya, the Embu, Emberre, Mwimbe, and Chuka; all these tribes have suffered much influence from and admixture with the Meru, Akikuyu, and Akamba, but the Chuka are the most distinct stock and the least touched by foreign influence. As this is a serious anthropological study, it is to be regretted that a summary of the physical measurements taken has not been given in the book.

In some ways the Chuka seem to be a curiously negative people. They do not remember their own genealogies and have very little knowledge of their history. These two deficiencies are accounted for by their customs and beliefs. They have no chiefs, the government being vested in councils of elders similar

to those of the Masai, though war leaders, through their personal prowess, may gain considerable eminence. Major Orde Browne says that there is no belief in a survival of any kind after death; he records no trace of ancestor worship; and corpses are left to be devoured by hyenas. Considering the importance of the ancestral spirit in every department of life among the Akamba and the Akikuyu, and assuming that Major Orde Browne has not been misled, this negative side of Chuka belief may be due to their Meru ancestry. The Meru are related to the Masai, among whom ancestral spirits appear to be relatively unimportant, and only the chiefs are buried. Like the Masai, the Chuka drink blood and milk mixed, but three months must elapse between the eating of meat and the drinking of milk, unless a special berry is taken as a purification. There are no rain-making chiefs, but a certain clan, the Ithaga, who are mostly smiths, are believed to have power over the rain; they also possess particularly potent curses. This gives substance to the statement by Mr. Hobley, who was told that the smiths of the Akikuyu all came originally from Ithanga, on the south side of Mt. Kenya ("Bantu Beliefs and Magic," p. 167). Akikuyu smiths can also inflict powerful curses. The system of *thahu*, ceremonial uncleanness, which pervades Chuka life, is essentially the same as that of the Akikuyu. A man may become *thahu* for a variety of reasons, many of which seem trivial to the European; in spite of this there is no doubt that tribal morality is dependent on this system, for the most potent weapon of the council of elders is their curse, which renders a man *thahu*. This book is of value and deserves a better index.

(2) Mr. Torday's book will appeal both to the general reader and to the anthropologist. There is plenty of adventure, gaily told; there are stories of cannibals, pigmies, gorillas, and natives who, not having met Europeans before, seemed to have no desire to make their acquaintance. Mr. Torday, however, was of a different mind; he wanted to know the various natives of the Congo, and succeeded in great measure. About fifteen years ago he was the first white man to stay in the Bushongo capital. He made friends with the king, prime minister, and other court officials, including the official historian. His researches into the history of these people disclosed a list of 121 successive kings, and the fact that, during the reign of the 98th, there had been an eclipse of the sun, enabled him to fix the date of that reign at 1680.

The account of these highly organised, peaceful, and industrious people is fascinating; their arts and crafts are probably the finest in Africa. Tall individuals with refined Hamitic features are conspicuous among the aristocrats in general, and especially those of the

royal clan, the Bambala, forming a contrast to the common Bantu population. Tradition relates that the first Bushongo king came from a far country in the north, and that in the journey to their present home the Bushongo crossed four great rivers. Mr. Torday has produced considerable evidence to show that this tradition is correct, and further, that Hamitic invaders from the neighbourhood of Lake Chad came south some time in the sixth century, conquered the Bantu inhabitants, who were closely akin to the Baluba, and founded the Bushongo nation. Mr. Torday saw reason to suppose that, between the Kasai and Loange rivers, he would find among the Bakongo and Bashilele a people similar to the original Bambala, before their admixture with the Baluba. The country had never been visited by white men before and was hostile to strangers; his adventures in this region make good reading, but, on account of the hostility and suspicion aroused, ethnological work was scarcely possible, and he failed to discover the evidence he was seeking. He was, however, rewarded by finding a high percentage among the Bashilele with Hamitic features.

(3) Returning to Mr. Norden's book, we learn that the author travelled from Lake Tanganyika to the Atlantic, and that he stayed in government stations, plantations, missionary stations, mining centres, and native villages, upon all of which he makes remarks with an extreme naiveté. Whereas he was able to make first-hand observations on the government's servants, missionaries, and traders personally, his comments on the natives are culled either from these former, or from the explanations of his boy, Pierre, and suffer accordingly. Thus, of the Bushongo, he states that the Lukango is the king, but the Nyimi is the supreme judge. As a matter of fact, there is no trace of such a division of function, both of which are held by the Nyimi; Lukango is the Balabu title for the Nyimi. The government of this nation was fully investigated by Mr. Torday and published in his "Notes ethnographiques" (Bruxelles, 1910), and it is to be regretted that Mr. Norden has failed to add to our knowledge of these interesting people.

BRENDA Z. SELIGMAN.

### Schools of Psycho-Analysis.

*Sigmund Freud: his Personality, his Teaching, and his School.* By Fritz Wittels. Translated from the German by Eden and Cedar Paul. Pp. 287. (London: G. Allen and Unwin, Ltd., 1924.) 10s. 6d. net.

THIS critical history of the psycho-analytical movement, as seen from within by Dr. Fritz Wittels, is of necessity, and admittedly, biased by his own temperament. He describes how five years of friend-

ship with Freud was followed by an estrangement, which, however, has not prevented Freud from acknowledging the merits and pointing out the drawbacks of the book in a letter from which extracts are reproduced as an introduction. A biography is combined with a running criticism of Freud's views as their development is described, and the personal conflicts are traced that led in turn to the secessions of Jung, Adler, and Stekel, for the last of whom the author expresses an admiration which obviously influences his own opinions. The picture he draws of the faithful disciples who will recognise no other authority than Freud, and of the dissentients who became outcasts from the fold, has few likenesses in the history of science. The pioneer psycho-analysts were surely not like other people, and for this a glance at the history of the movement offers explanations. The contumely and abuse that fell upon them ensured the selection of those careless of the opinion of the herd, whilst the slighted herd instinct demanded in turn the formation of a defensive sect. The absence of effective criticism free from emotional bias aided the isolation from, and contempt for, the outer world of science and medicine.

That psycho-analysts have resigned themselves to this condition of affairs is perhaps the most unfortunate outcome of the position. Wittels notes the resemblance between the schisms of the psycho-analytical schools and those of the early Christian sectaries, and in himself carries the resemblance a stage farther. Nothing matters to him except these schisms; no opposition to Freud exists but from the seceders; the world consists of believers and dissenters on one hand, and of Turks, infidels, and heretics on the other, and the latter do not count. That Freud himself did not willingly accept the position is shown by his remarks during the Nuremberg congress in 1909: "It is absolutely essential that I should form ties in the world of general science. I am getting on in years, and am weary of being perpetually attacked."

For the ordinary reader of this book—which gives an outline of Freudian theory as approved by Dr. Wittels—there will be difficulty in separating science from art, observation from deduction, accepted theory from individual speculation, and it is indisputable that the same difficulty will meet him in many books on psycho-analysis. Yet it is desirable that psycho-analysis should be subject to the canons of science, and on p. 54 the author indicates a starting-point at which scientific judgment may be applied. He declares that the psycho-pathologist can find in the unconscious an adequate cause for neurotic anxiety and can demonstrate it to others. The statement is definite, and there are many psycho-pathologists who will support it; that

the primary basis of anxiety is the sex instinct in some pathological development is likewise a question that may be scientifically approached in an atmosphere free from the dust of prejudice. The barrier that Dr. Wittels accepts as part of the natural order of things must be broken down in the interests of science and medicine as well as of psycho-analysis. M. C.

### Our Bookshelf.

*Bituminous Substances : Scientific Progress of Practical Importance during the last Fifteen Years.* By Dr. Percy Edwin Spielmann. Pp. xvi+206+8 plates. (London : Ernest Benn, Ltd., 1925.) 15s. net.

BITUMINOUS substances are here interpreted as "asphalt" in its varied form and utilisation, but the treatment of the subject is essentially physico-chemical, wherein this volume differs as a text-book from its predecessors.

The complexity of the chemistry of petroleum, more particularly its products of high boiling point and molecular weight, is well known, but the chemistry of asphalt is the least understood of all. For this reason it was a bold effort to compound in a small volume the essence of our knowledge, so far as it has progressed, of the constitution, properties, effects of heat, ageing and solvents, critical physical and chemical tests and behaviour under diverse experimental and practical conditions, of this remarkable substance. From the earliest times (according to the author, 12,000 years ago) there are isolated references to the utilisation of bitumen in the service of man, chiefly as an adhesive material; history further shows that throughout the progress of civilisation, man availed himself of this natural product without in the least understanding its true nature and composition. To-day we recognise extended uses of bitumen, but theory still lags far behind practice, and our knowledge of its chemistry, as indeed our methods of investigating it, are mainly empirical, if not actually arbitrary.

In "Genesis of Petroleum" the author revealed his knack of extracting successfully the pith of published work from many sources (often inaccessible to most people), and of presenting it in the form of a coherent summary of progress; in the present work he does much the same thing, supplementing data thus obtained with results of personal research and that of his former colleagues. One cannot but welcome a book of this description, even though it must be regarded as an interim report and be subject to the limitations of such publications. H. B. M.

*Money Scales and Weights.* By T. Sheppard and J. F. Musham. Pp. vi+221. (Hull: A. Brown and Sons, Ltd.; London: A. Brown and Sons, Ltd.; Spink and Son, Ltd., 1924.) 10s. 6d.

THE versatile curator of the Hull Museums has collated in this volume the notes on coin scales and weights—mainly with reference to the unique collection in his charge—which have appeared during recent years in the *Numismatic Circular*, together with a few addenda. Mr. Musham has added a descriptive catalogue of the comprehensive series of English coin weights collected

by him and acquired by the Hull Corporation. The result should be of interest to the collector and the antiquary. As a reference work, however, its usefulness would be much enhanced by the addition of a general index and a bibliography and by a careful editorial revision. One would expect the scales to be grouped according to their principles of construction, whereas the *fundamentum divisionis* that has been selected is the structure and decoration of their cases. The descriptions of the various scales are disparate and contain much needless repetition. Dates are sometimes assigned without any apparent evidence; the balance described under No. 151 is given the date 1765, but the patent for it was not granted until 1774. The word "crescentric" is persistently used for "crescentic."

A chat with a practical scale-maker would have facilitated clearer description and obviated, for example, the use of the term "oil-caps" for balance bearings (pp. 75, 79, etc.). The importance of the nature of these bearings does not seem to have been grasped, nor is investigation made as to the probable degree of accuracy with which the instruments may have fulfilled their functions. The illustrations are copious and good, but the explanatory diagram on p. 31 suffers from excessive reduction.

*Text-book of Cellulose Chemistry : for Students in Technical Schools and Universities as well as for Cellulose Experts.* By Prof. Emil Heuser. Translated from the second German edition by Clarence J. West and Gustavus J. Esselen, Jr. Pp. xi+212. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 12s. 6d. net.

THE literature of the chemistry of cellulose is prodigious in quantity and very variable in quality, and bits of it may be found in anything from treatises on tropical agriculture to the prospectuses and reports of limited liability companies. Attempts have been made to collect it all between one pair of covers, but these have mostly resulted in tomes for reference rather than in books for students. With the development of technical education it has apparently been found necessary to teach students connected with the textile, paper, and other industries something about the chemistry of their common raw material—cellulose—and hence the demand for a text-book such as that under review.

Bearing in mind the extent and character of the literature to be dealt with, Prof. Heuser has been remarkably successful in bringing the data into some sort of order and compressing them into reasonable compass. British chemists will, however, be somewhat surprised to find how small a part the British contribution to knowledge of the chemistry of cellulose, both on the scientific and the technical sides, plays in Prof. Heuser's story. This feature of the book seems to have struck the translators, and in the chapter on the constitution of cellulose they have felt it necessary to insert a note describing some of the very important work on this subject done by Hibbert in the United States and by Irvine and his collaborators in Great Britain. Work on cellulose esters is so voluminous that the author is perhaps not unreasonable in devoting 47 pages to it and only 8 to cellulose ethers, though the latter may be much more important in their bearing on the constitution of cellulose than the former. T. A. H.

*The Psychology of the Unadjusted School Child.* By Dr. John J. B. Morgan. Pp. xi+300. (New York: The Macmillan Co., 1924.) 9s net.

THIS is a valuable addition to the literature of the psychology of education and should be read with great profit not only by professional psychologists and teachers, but also by every one who is interested in that most artistic of the arts—character-building. The work is, in a sense, a study of individual differences that are emphasised almost to the point of being abnormalities, and an attempt to trace these to their causes.

After a section discussing the nature of mental disturbances, five sections follow in which various ways of adjustment or mal-adjustment with reality are lucidly, simply, and accurately sketched out. There is the direct struggle and compromise with reality in its various forms. This is treated in some detail, and always with practical and useful suggestions for the teacher or parent as to how the growing mind should be helped in its process of adjustment, and not hindered, as is often the case—even up to the point of fostering mal-adjustment—by the treatment it receives at their hands. Section vii. contains a chapter upon the prevention of abnormalities of character. This is not, and cannot be in the present state of our knowledge, final or exhaustive; but it is all on the right lines, and follows such principles as have already been established by psychology.

The main conclusion which is reached by Dr. Morgan is that, since education is not merely the imparting of information, but also the formation of character, it is not the technique of teaching, but an understanding of human nature which can only be obtained by studying mal-adjustments that is needed by the teacher. Conflicts begin early in life; and mal-adjustments take root and grow readily. To prevent them, or to root them out before they have had time to consolidate themselves, is really the highest privilege of the teaching profession, a privilege which the teacher should understand how to exercise.

*Fundamentals of Vocational Psychology.* By Prof. Charles H. Griffitts. Pp. xiii+372. (New York: The Macmillan Co., 1924.) 12s. net.

THE problem of vocational guidance is that of ascertaining the special aptitudes of any individual for a given trade or profession. Accordingly its solution lies in a study of individual differences in such a way that they may be practically determined in any given case. Much attention has been given by psychologists to this matter of late, and Prof. Griffitts' book contains an excellent presentation of vocational psychology so far as it has been yet worked out. Physiognomy is discussed at great length as an indication of aptitudes; but the conclusion is reached that inferences from it are of little validity, and the interview is emphasised as the best guide in the selection of employees and, generally, in vocational advising. The psychological aspects of the interview are carefully presented, and rating scales with regard to character dealt with. As supplementary to the interview, tests are recommended as "devices which under certain conditions give results which are valuable to the interviewer."

It will be seen that the author is not one of those who expect everything from tests in the present immature state of this department of applied psychology. Indeed, he recommends great caution in their use. A number of tests are given in detail as to methods and technique; but the reader is reminded that there can be no applied psychology without a background of sound theory; and, in consequence, general psychological principles are emphasised throughout.

*Rejuvenation: the Work of Steinach, Voronoff, and Others.* By Norman Haire. Pp. 223 + 2 plates. (London: G. Allen and Unwin, Ltd., 1924.) 7s. 6d. net.

THE author set himself the task of writing a book that should make the subject of rejuvenation intelligible to the educated layman and yet be sufficiently technical to satisfy the medical reader in search of a general statement of the subject. He has succeeded in his attempt. The book can be recommended to those to whom it is addressed. A layman seriously seeking information will find in it a fair statement of the facts concerning the operative methods by which rejuvenation is attempted and a trustworthy analysis of the results of the work that has already been done in this particular field. Its great value to the medical man is that it gives a review of the whole subject and guides one to deeper reading.

A very complete list is given of the recorded cases, both in animals and man, and the relative merits of vasoligature, gonad implantation and irradiation are discussed. The American and Continental literature has been well searched and the records tested against the author's own case-histories. The author points out that the earlier reports emphasise specially the sexual rejuvenation, and maintains that in the human beings this is by no means the most important or most striking result of the operation.

*The Extra Pharmacopœia of Martindale and Westcott.* Revised by Dr. W. Harrison Martindale and W. Wynn Westcott. Eighteenth edition, in 2 vols. Vol. I. Pp. xxxviii+1163. (London: H. K. Lewis and Co., Ltd., 1924.) 27s. 6d. net.

THIS book is well known to all British pharmacists and medical men, and the frequency with which new editions have to be issued is sufficient indication of its trustworthiness as a work of reference to the enormous number of drugs, chemicals, and ingenious combinations of these now used in medicine. It is more than four years since the last edition was published. In the interval, many advances have been made in the treatment of disease, and the authors have shown their usual skill in selecting from the pharmaceutical and medical literature that accumulates during such a period those items that are likely to be of permanent value. While full attention is given in the new edition to such important subjects as the use of insulin in diabetes, the treatment of syphilis with preparations of bismuth, new synthetic remedies for trypanosomiasis, and new methods of dealing with leprosy, the numerous small advances in medicine and pharmacy by which constant progress of a less striking character is being made, are not neglected.

### Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.*]

#### Ether-drift and the Relativity Theory.

THE brief messages in the daily press with regard to Prof. D. C. Miller's experiment have aroused much interest and bewilderment; it is therefore of great value to have Dr. Silberstein's authoritative account in *NATURE* for May 23. Comment on the experiments themselves would be out of place until the details are published; but it may not be premature to point out that the surprising hypothesis of ether-drift, by which it is proposed to account for the results, is disproved in advance by the daily measurements at astronomical observatories. These measurements constitute a test for differential ether-drift much more delicate than the Michelson-Morley experiment.

According to Dr. Silberstein's summary, the ether is gliding over the earth at a speed which increases from about zero at ordinary ground-level to 10 km. per sec. at the summit of Mt. Wilson. There is thus a rapid rotational motion of this part of the ether. So early as 1845, Sir George Stokes showed that in order to conform with the astronomical facts of aberration the motion (if any) of the ether must be *irrotational*.

The difficulty is seen vividly if we consider the curvature of a ray of light coming to us from a star, taking account of this ether-flow. A ray which is vertical at the summit of Mt. Wilson will on reaching sea-level have an inclination of  $7''$ . Thus observations of absolute star-position at mountain observatories and at sea-level will be discordant by amounts of this order. An error of the order  $7''$ , variable according to the time of day, would play havoc with fundamental astronomy.

The Michelson-Morley experiment was originally performed because it was thought—mistakenly, as we now realise—that it would measure *absolute* ether-drift. For many years it was in sole possession of this field of inquiry. In the new application to *differential* ether-drift it is invading a field in which the facts have long been established by delicate observations, and it is difficult to regard it as a serious competitor.

A. S. EDDINGTON.

Observatory, Cambridge,  
May 25.

#### The Faraday Benzene Centenary.

In a recent letter (*NATURE*, April 18), I ventured to counsel chemists to go back to the land—to study Faraday. Since then, in the *Times* (May 16), I have urged that Faraday's great discovery of benzene, one hundred years ago, should henceforth be commemorated on June 16, the day on which it was communicated to the Royal Society of London. Surely we should make this a saint's day in our chemical calendar. The public has its Saint Lubbock's days, for the mere purpose of resting from its labours—in days when labour is beginning to be regarded as a work of supererogation. Why not a chemists' rest-day for the purpose of contemplation: to give emphasis to our recognition of the importance of Faraday's discovery and its astounding consequences: more particularly, as an outward and visible sign of our belief in the method we wield in our search for truth?

As an analytical achievement and as an astounding demonstration of the power of the human intellect to penetrate into the mysteries of matter, the great benzene chapter in organic chemistry, built upon the foundations Faraday laid, may be ranked above all others. It is for chemists to show that our science of chemistry has a mission in society—to make, at least, its simple principles understood. This we must do, if workers in any way believe that the method they wield is of moral significance and not a mere means of dissecting Nature.

It is clear that the politicians are not with us and that even industry has but a half-hearted belief in our ability to serve it. That the public do not understand us is certain. Our nation is behind other nations in appreciation of the work done by the scientific inquirer and its value to society. An occasion like the approaching centenary would command wide sympathy abroad but ordinary engagements will come before it with our politicians. We owe it to ourselves to break down the barriers of ignorance, there in large measure because of our constant disregard of opportunity and our failure to cultivate public attention and appreciation.

At whatever effort, chemists are called upon to give proof, at the approaching centenary celebrations, that they, at least, can appreciate the spirit in which Faraday led the way in the battle against ignorance, as an exponent of the laboratory method and as a philosopher. The advice he tendered, best studied in his writings and in the striking biography we owe to Bence Jones, is of incomparable value. It were well if we had a book of excerpts of his sayings, to guide us in our moments of weakness and keep us in the straight and ever narrow path of scientific rectitude. The poets have their anthologies: why not the philosophers?

Let us, at least, now show that we are not wanting in public spirit in our own cause.

HENRY E. ARMSTRONG.

#### Depth-recording with Plankton-nets.

THE concise account given by Mr. F. S. Russell in *NATURE* of April 25, of the behaviour of ring-trawl nets when towed, enables an attempt to be made to solve the paradox of his diagrams. The shape of the warp during each haul may be compared with an imaginary catenary of reference. For this purpose the resistance of the net may be replaced by a horizontal force acting at the lowest point of an imaginary warp constituting a true catenary, and use may be made of Mr. Russell's observation that it is the practice to keep the angle of entry of the warp into the water constant at  $40^\circ$ . With a constant angle of  $40^\circ$ , the ratio of *bight* to *dip* of a true catenary is 5.4954, and the ratio of *span* to *dip* is 4.9955, *bight* and *span* being measured between supports at a common level. In terms of these two constants, and of the particulars of the wire-rope, may be calculated the tension at the winch, the tension at the lowest point of the catenary, and the resistance of the warp through the water. Moreover, from the given particulars of the net an estimate may be made of its resistance for any required speed. Then, by equating the expression for this resistance, to the tension at the lowest point of the catenary, the speed through the water may be estimated. At high speeds there would be disturbances; but as Mr. Russell states that the engine was run "dead slow," there is sufficient probability of an approach to a solution that will not encroach too far into the region of piscatorial credulity, to justify this method of interpretation.

From the dimensions given on p. 603, the resistance of the net may be judged to be about 68 K<sup>2</sup> lb., and the resistance of the 2-in. steel-wire rope to be about 0.76 K<sup>2</sup> lb. per fathom, where K is knots. In the table, the results of the calculations are arranged in the same order as the hauls in Mr. Russell's diagrams, Figs. 1, 2, and 3 here repeated.

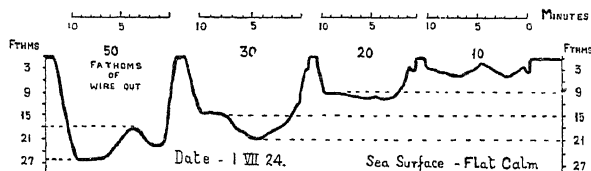


FIG. 1

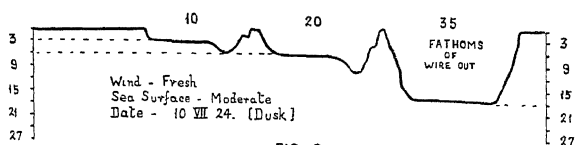


FIG. 2

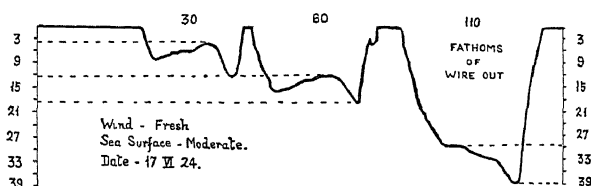


FIG. 3.

FIGS. 1, 2, and 3 are tracings of records obtained during three series of hauls. Each haul, represented by a curve, is of ten minutes' duration (time of "shooting" and "hauling" not included). The net enters the water on the right-hand side of each curve. Above the curve for each haul is inserted the length of wire used, in fathoms.

instrument for recording depths was working perfectly. Consequently the anomalies referred to by Mr. Russell are to be attributed primarily to variations of speed throughout a haul. At low speeds these changes of speed are probably large compared with the speeds. There were also changes of angle. Column 10 is only a rough estimate, but the general character of the warp-resistance is demonstrated.

If further tests are carried out, it might be possible to obtain direct measurements of tension at the winch for comparison with Column 6. A note on speeds would also be useful for comparison with Column 8. It would be an easy matter to prepare tables in a similar manner for a useful range of angles and lengths of warp.

ROLLO APPELYARD.

April 30

### The Origin of Adaptations.

LAST December, before the American Society of Zoologists, Prof. M. F. Guyer delivered an admirably lucid and well-reasoned address entitled "Soma and Germ." Near the end he says (*American Naturalist*, March-April, 1925):

"The fact is that biologists have never yet hit upon an explanation of the marvellous adaptedness of organisms to their environment which does not put a tremendous strain upon our credulity. And when we view it with unprejudiced eye it seems to me that the theory which would attribute adaptation to the mere accumulation of such chance variations as happen to be favourable is the most incredible of all. Time and again in the past, according to paleontologists, whenever new possibilities for existence occurred, forms of life admirably adapted to those conditions have come to occupy the new habitat. In some way the environment has moulded these new inhabitants to its bounds, and it takes more faith than I personally possess to believe that it has all been done by the negative method of killing off, generation after generation, the non-conformists—those in which the happy accidents, or rather the innumerable inter-related series of accidents, has not occurred."

(1) Length of Warp.	(2) Whole Bight of Catenary.	(3) Calculated Dip Bight 5.495	(4) Observed Dip. From Figs 1, 2, and 3	(5) Calculated Whole Span of Catenary. 4.995 × dip.	(6) Calculated Tension at Winch $t = 10.25 \times \text{dip}$	(7) Calculated Tension at lowest Point of Warp $t_0 = 7.86 \times \text{dip}$	(8) Calculated Speed. $K = \sqrt{\frac{t_0}{68}}$	(9) Calculated Resistance of Net. $68 K^2 = t_0$	(10) Calculated Resistance of Warp. $0.76 K^2 \text{ L.}$
L. Fathoms.	Fathoms.	$v$ Fathoms.	Fathoms.	Fathoms.	lb.	lb.	Knots.	lb.	lb.
10	20	3.64	1.5 to 7	18.2	37.3	28.6	0.65	28.6	3.2
20	40	7.28	9 to 11	36.4	74.6	57.2	0.92	57.2	12.8
30	60	10.9	15 to 21	54.5	112	85.7	1.12	85.7	28.9
50	100	18.2	18 to 27	90.9	187	143	1.45	143	80.0
35	70	12.7	18	63.4	130	99.8	1.21	99.8	39.3
20	40	7.28	6 to 9	36.4	74.6	57.2	0.92	57.2	8.5
10	20	3.64	3 to 7	18.2	37.3	28.6	0.65	28.6	3.2
110	220	40.0	29 to 39	199.8	410	314	2.15	314	387
60	120	21.8	13 to 19	108.9	223	171	1.58	171	115
30	60	10.9	5 to 13	54.5	112	85.7	1.12	85.7	28.9

Comparing columns 3 and 4, the calculated dips are seen to be in agreement with the corresponding average of the observed dips, except in the third haul, which happens to be also the one singled out by Mr. Russell as an example of a "bad" result. Fortunately, the tenth haul is identical with the third in length of warp, and in this instance the dip indicated by the imaginary catenary, Column 3, is fairly representative of the observed average, Column 4. It may be inferred that the Admiralty

Without disputing the extraordinary importance and interest of Prof. Guyer's researches we may, I think, present certain considerations which should qualify his conclusions. Presumably it is agreed that alterations in the germ-plasm, which find expression in heritable variations, are caused in some manner—that is to say, are part of a connected sequence of events. The question is, whether the causative agents, whatever they may be, are purposeful in the sense of being directly related to the

functional significance of the resulting changes. Prof. Guyer appears to think so, because in his view the development of adaptations in so many organisms and in such diverse ways makes any other view too great a strain on credulity.

Many others have held similar opinions. The distinguished entomologist, the Rev. Wm. Kirby, wrote in 1800:

"This visible world, by types indeed and symbols, declares the same truths, as the bible does by words. To make the naturalist a religious man, to turn his attention to the glory of God, that he may declare his works, and in the study of his creatures see the loving kindness of the Lord, may this in some measure be the fruit of my work."

Because scientific men are no longer accustomed to use such phraseology, they overlook the fact that such writers as Kirby were not expressing mere conventional piety, but were stating what they regarded as profound truth properly deducible from their researches. The contrary view, that things happened by "chance," was as difficult for them to believe as it is for Prof. Guyer. No one who thinks deeply can altogether escape convictions of this sort, and the mind is wholly baffled in attempting to connect the higher flights of the human intellect with the ordinarily understood products of metabolism. But while thus confessing sympathy with Prof. Guyer, and no less with the Rev. Wm. Kirby, it may be well to consider "with unprejudiced eye" what are the real findings of palæontology.

The recent work of the physicists has enormously increased our estimates of geological time. The significance of this for biology has not yet been fully grasped. Evolution has been a process of extraordinary slowness. Modern work on extinct animals and plants, as shown by their remains, emphasises the amazing permanence of structures. Consider first the limited number of fundamental tissues which go to make up animals. Then, when we study fossil insects, plants or molluscs, we find indeed great numbers of species, but these developed largely by a sort of shuffling of characters, with surprisingly little that is new even in millions of years. Mammals have evolved much more rapidly, yet we who contemplate the results are always prone to speed up mentally the process, after the fashion of the cinema. Palæontology also teaches that innumerable forms have failed to become adapted, and have died only locally or entirely. In short "admirably adapted" species have *not* appeared "whenever new possibilities for existence occurred," but have developed here and there, during vast periods of time, naturally accumulating on the earth and filling it with beings whose origin baffles our imagination. In the long run, and at the sacrifice of innumerable lives, Nature scores an amazing success, but our impatient thought cannot tediously follow the process. The contrary view, that the germ-plasm is permanently altered as easily and significantly as Dr. Guyer seems to postulate, is the one which strains our credulity, because it should apparently give us modifications far more rapid and purposeful than the observed facts indicate. T. D. A. COCKERELL.

University of Colorado,  
Boulder, March 17.

#### The Jet-wave Accelerometer.

In the issue of NATURE of April 11, p. 530, Prof. Paul Kirkpatrick has, under the heading "Absolute Seismometry: a New Method," described a device in which a liquid jet is used for the recording of the motion of a body.

A similar apparatus, the jet-wave accelerometer,

has during the last year been studied in my laboratory. I think I may, therefore, be able to throw some light on the subject in question, and especially on the problem: What is actually recorded by the jet? I may mention that it was a paper by Prof. K. Prytz, "L'accélération mesurée au moyen d'une flamme" (*Le Journal de Physique et le Radium*, Sér. 6, 4, 1923), which caused me to take up the investigations on the jet-wave accelerometer eighteen months ago. It occurred to me that the flame used by Prof. Prytz might be considered as a jet, and that consequently a liquid-jet might be utilised for the same purpose as the flame.

When a perpendicular jet is attached to a body moving to and fro in a horizontal direction, we may ask, *What is recorded by the relative deflexion of the jet at a certain distance  $x$  from the jet-hole?* It may easily be shown that, when  $x$  is sufficiently small, the acceleration of the body is recorded, while at greater distances the velocity of the body is traced.

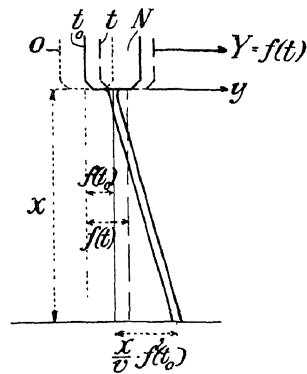


FIG. 1.

The first statement may be proved in the following way. If the motion of the nozzle  $N$  (Fig. 1) is represented by

$$Y = f(t) \quad (1),$$

the velocity is  $f'(t)$  and the acceleration  $f''(t)$ . In order to calculate the relative motion of any jet-particle, say the particle which leaves the nozzle at the moment  $t_0$ , we have to apply the relative acceleration  $-f''(t)$  to the particle. If the deflexion is observed at so short a distance  $x$  from the nozzle that  $f''(t)$  does not alter essentially in the time used by the particle to travel through  $x$ , then the deflexion  $y$  is determined by

$$\frac{d^2y}{dt^2} = -f''(t_0) \quad (2),$$

from which we get

$$y = -\frac{1}{2}(t - t_0)^2 f''(t_0) = -\frac{1}{2}\left(\frac{x}{v}\right)^2 f''\left(t - \frac{x}{v}\right) \quad (3),$$

$v$  being the velocity of the jet. Thus,  $y$  records the acceleration with a delay of  $x/v$ , i.e. the time for the particle to move from the nozzle out to the distance  $x$ .

The second statement above is directly verified by an inspection of Fig. 1. From this figure it is seen that the deflexion at any distance  $x$  is given by

$$y = \frac{x}{v} f'(t_0) - [f(t) - f(t_0)] \quad (4).$$

When the deflexion is due to a vibratory motion, the quantity  $[f(t) - f(t_0)]$  will ultimately, as  $x$  increases,

become insignificant compared to  $\frac{x}{v} f'(t_0)$ , and then the deflexion may be written

$$y = \frac{x}{v} \cdot f'(t_0) = \frac{x}{v} f'\left(t - \frac{x}{v}\right).$$

The deflexion thus records the velocity  $f'(t)$  with a delay  $x/v$ .

In Fig. 2,  $\theta$  denotes the variation with time of the angular deflexion of a pendulum, with a period of about 3.3 sec., while  $y$  represents the relative deflexion of a water-jet attached to the pendulum and sheltered against the air-resistance. The deflexion was considered 9 cm. below the nozzle, and the level of the

water in the reservoir was 2 cm. above the nozzle. The  $y$ -curve was calculated from all the relative accelerations acting on the jet, *i.e.* the radial, the tangential, and the Coriolis acceleration. By means of a device which cannot be described in this paper, the moment of the passing through zero of the jet and the amplitude of the oscillations of the jet could be observed with a fair degree of certainty. The observations fell within the intervals indicated in the figure

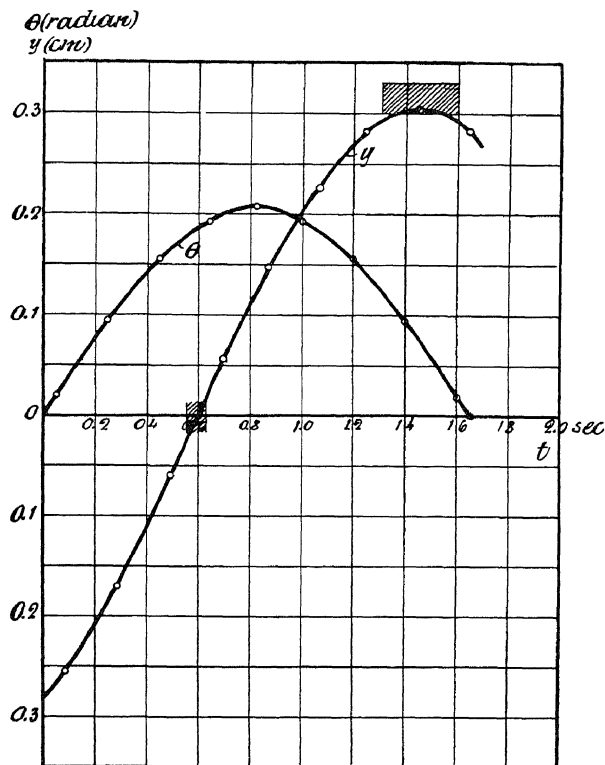


FIG. 2.

by hatching and thus closely confirm the theory. It should especially be noted that the observed amplitude agrees with the calculated. This means that the jet-wave recording the acceleration does not show any damping, a fact which was anticipated from earlier experiences with the jet-wave.

JUL. HARTMANN.

Physical Laboratory II.,  
The Royal Technical College,  
Copenhagen, April 16.

### The Origin of the Continents.

DR. R. H. RASTALL'S interesting article in NATURE of May 2, p. 646, raises what is perhaps the most difficult problem or group of problems that geophysicists have yet to solve. In considering the origin of the continents, the essential points to be explained are the restriction of the continental blocks to little more than one-third of the earth's surface and the marked asymmetry of their distribution. The formerly popular "tetrahedral" hypothesis, apart from its descriptive inadequacy, has hitherto failed hopelessly when confronted with the principle of isostasy. It clearly implies a process of lateral differentiation whereby the earth's store of granite could become strongly concentrated at the corners and along the edges of the alleged tetrahedron, leaving the interior of the faces, corresponding to the oceanic

areas, substantially free from granite. Otherwise the distribution would be unstable and therefore temporary. No one, however, has succeeded in devising any workable process arising out of the earth's contraction which would lead to such lateral concentration of the continental rocks.

The absence of a granitic crust from two-thirds of the earth's surface has often been correlated vaguely with the separation of the moon from the earth, but generally on the assumption that before separation took place the granitic crust not only existed, but was also uniformly distributed. Even if the earth lost two-thirds of its crust to the moon, the part retained would not remain in one hemisphere. Jeans has shown conclusively that if a thin crust floating on a liquid interior had ever been restricted to one side, it would break up and spread until the blocks were evenly spaced over the whole surface.

It is, however, highly improbable that a granitic crust ever existed as such while the more basic underlying materials were still liquid. It is much more in accordance with modern petrological ideas to consider that the constituents of granite (together with a large proportion of the water of the existing oceans) would remain fluid for some time after the bulk of the basic material beneath had solidified. On this alternative assumption I recently put forward the following suggestions in an attempt to explain the initial restriction of the continents (*Mining Magazine*, February 1925, p. 95). It seems most probable that the first solid silicate material to form would have the composition of peridotite and would accumulate at a great depth. Lying beneath it would be, presumably, the immiscible metallic core; and floating above it the still fluid magma from which more ultrabasic material and the whole of the basaltic and granitic materials were yet to be differentiated. After the separation of the moon the core of the earth would be relatively displaced to one side, and the magmatic ocean would therefore become deeper on one hemisphere than the other. At a later stage, when basaltic material had solidified, the residual magma would be granitic in composition, and this would continue to be confined to one hemisphere, provided that the viscosity of the interior had been high enough to prevent the displaced core from becoming central within the time then elapsed since the birth of the moon. If, finally, the granite solidified before the core attained a stable position, then a permanent departure from sphericity would be established. The earth would thus have had from the first a depressed heavy "Pacific" area, and a broad continental area standing high in virtue of the lower specific gravity of its rocks.

Dr. Jeffreys tells me that if the internal viscosity had been sufficiently high to retard the recovery of the displaced core to the extent required by the above suggestions, then it becomes increasingly doubtful whether the moon could have separated according to the resonance theory. It is possible, however, that an alternative mode of origin for the moon may be found, and that it may not be necessary to abandon the possibilities arising from a displaced core.

It will be noticed that neither the "stripping off" nor the "displaced core" hypothesis gives a distribution of the continental masses corresponding to that which now exists. The one distribution is too dispersed, the other too circumscribed. But in neither case need this alone be regarded as a necessary defect. Interest in the Wegener hypothesis of continental drift has made familiar the conception of lateral movements, and that these may be intermittently possible must now be seriously considered in view of Joly's theory of a periodic fusion and solidification of sub-crustal magma due to the accumulation of

radio-thermal energy. The actual distribution of the continents may therefore be the result of their geological history. Their lateral restriction presents a more fundamental problem and if it cannot be correlated with the orbit or former proximity of the moon, it will be difficult to discover any other external constraint capable of providing an explanation.

ARTHUR HOLMES.

Department of Science,  
University of Durham,  
South Road, Durham.  
May 5.

### The Cresswell Engravings.

THE account in NATURE of May 2, p. 658, of the excavations at Cresswell Crags, and the discovery of engraved bones, calls for some comment from me as being the first to cast doubt on the authenticity of the engravings. Some time ago, and before the meeting, I expressed the opinion to my fellow cave-worker, Mr. A. Leslie Armstrong, that the markings



FIG. 1.—Portion of an eroded human skull, with (below) tracing made to show animal heads by outlining some of the eroded grooves.

on the three bone fragments from Mother Grundy's Parlour were due to the action of roots. I also told him it was a mistake to outline the figures in Chinese white. At a later date the bones were submitted to Sir William Boyd Dawkins and he brought them in to me for an opinion. I was able to convince him, by means of similarly marked bones in the Manchester Museum from excavations of various dates, that, beyond the two convergent incised lines on the "rhinoceros" piece, the markings on the three bone fragments were due entirely to root-action and were not of human origin.

The most convincing piece of evidence is a human skull from a tumulus near Helyhead. The outer surface of this skull is scored in all directions by characteristic half-tunnels formed by the action of roots, and it is quite easy by following certain of the grooves to make animal figures of them. The accom-

panying photograph (Fig. 1) shows a small portion of this eroded surface, slightly above natural size. I cannot see the slightest difference between the markings on this skull and those on the three Cresswell bones. The misinterpretation placed upon the markings on the latter mars what is otherwise an important piece of work. I can speak with some knowledge about Mr. Armstrong's skill as a cave-digger.

The Pin Hole example is a genuine artifact and is of ivory, as reported to Mr. Armstrong and to Sir William Boyd Dawkins. It has been engraved with a conventional pattern by human agency, and contrasts strongly with the three bone fragments from Mother Grundy's Parlour.

It should be pointed out that the Mills mentioned in the previous account should be Mello.

J. WILFRID JACKSON.

Manchester Museum, Manchester,  
May 12.

### Effect of High Tension Electric Fields upon the Discharge of Locomotive Gases.

OWING to the simultaneous use of steam and electricity on the Swiss railways during the process of gradual electrification, a curious physical phenomenon is seen when the mixture of smoke and vapour from a steam locomotive comes within the electric field produced by the overhead conductors, which operate at a pressure of 15,000 volts, and a periodicity of 17 per second.

Under certain conditions the smoke and steam particles are seen to be in violent agitation, very rapid and rhythmical. The phenomenon is not readily observed, the special conditions requisite for its production being realised only on rare occasions. It is not observable in the compact white clouds sent out by a heavily loaded locomotive, nor during the emission of dark smoke just after firing; neither is it seen during the heavy discharge from a locomotive while starting a train. The most favourable conditions appear to occur during periods of minimum discharge of steam and smoke, when the singular palpitation suddenly appears and just as quickly disappears.

Owing to the fugitive nature of the phenomenon it is difficult to count the number of palpitations, but they are certainly of the same order as the alternations in electric tension. This and the requisite attenuation of the water droplets seems to indicate an essentially electric origin for the phenomenon. On the other hand, it is evident that the appearance is in no way connected with electrical discharge of the kind frequently seen between clouds in a thunderstorm, because the palpitation is invisible at night.

During the day-time the palpitation is seen most clearly when the discharge from the locomotive appears "dark grey" against a bright background of sky, or when it appears as a white cloud against an overcast sky. Both these conditions point to an alteration in opacity and, correlatively, an albedo of the cloud mass, caused by a series of alternate condensations and re-evaporations occurring in synchronism with the variations in electric field. Apparently, under certain conditions of saturation, a positive charge will favour the formation of drops, whereas a negative charge leads to their disappearance by evaporation in the warm gases.

In order to test the above explanation I attempted an experimental laboratory verification, using a Klingelfuss induction coil which was controlled by a Roget helix dipping in mercury, and breaking the circuit 10 or 12 times per second. The pressure at the terminals reached about 40,000 volts. The spark

gap plate was extended by a metal rod, extending to within a few centimetres of a narrow orifice, through which issued a jet of water vapour from a small boiler. The boiler was heated electrically in order to avoid the production of disturbing ions through combustion.

The steam remained almost invisible so long as the induction coil remained inoperative, but, as soon as the helix interrupter was started and the intermittent electric field established around the metallic rod, the appearance of the steam jet changed, its visibility fluctuating in synchronism with the dipping of the Rogot interrupter and with the polarity of the electric field. When the vertical rod was positively electrified the phenomenon was strongly marked, but when the conductor was charged negatively the results were not readily observable.

Although this simple experiment did not reproduce fully the conditions obtaining on the electric railway, it illustrates and corroborates the hypothesis of the alternate condensations and rarefactions being caused by the alternating electric field.

P. L. MERCANTON.

Meteorological Office,  
Lausanne, Switzerland.

### Intensities in Band Spectra.

THE correspondence principle alone is not sufficient to determine accurately the intensities of spectral lines for small values of the quantum numbers. But, as recent investigations have shown, it seems that, in the case of multiplets, this is possible with the aid of the rules found by H. C. Burger and H. B. Dorgelo (*Zeit. f. Phys.*, 23, p. 258, 1924), which state that the sum of the intensities of the lines coming from (or going to) a certain level must be proportional to the inner quantum number (= statistical weight) of this level.

It is to be expected that these rules will also hold good for band spectra. Some of the results obtained by applying them to the lines of a band are summarised below.

(1) In a band with only a *P*- and *R*-branch without fine structure the intensities are, if the statistical weights a priori are  $2m-1$ , proportional to:

$$\left. \begin{array}{l} m \rightarrow m+1 : m e^{-E_m/kT} \\ m+1 \rightarrow m : m e^{-E_{m+1}/kT} \end{array} \right\} \quad (1)$$

For small rotational quantum numbers the intensities are symmetrical with respect to the missing zero line.

(2) The *P*-branch is somewhat more intensive than the *R*-branch, the quotient for the two maxima being  $e^{\sqrt{2}\sigma}$ , if the rotational energy can be represented by

$$E_m = \frac{h^2}{8\pi^2 I} m^2, \text{ and we put } \frac{h^2}{8\pi^2 I k T} = \sigma.$$

(3) If the band lines are non-resolved doublets as, for example, in the CN-bands, the intensity distribution must be another one, as in the case of true simple lines. With the interpretation of the fine structure given by A. Kratzer (*Ann. d. Phys.*, 71, p. 72, 1923), or an alternative one proposed by the present writer (*Physica*, 5, 1925), the factor  $m$  in (1) must be changed by  $2m-1$ .

(4) In such bands as the CN-bands, one or more lines in the neighbourhood of the zero line are simple instead of unresolved doublets. Such lines are not weaker than would be expected from the neighbouring lines, but have the normal intensity.

(5) There are some possibilities which give alternating intensities, as observed, for example, in the nitrogen and hydrogen bands.

Equation (1) is the same as that found by E. C. Kemble (*Phys. Rev.*, 25, p. 1, 1925) in removing the degeneration of the two rotational degrees of freedom

by an external field and applying the correspondence principle to the non-degenerated system. Such a procedure gives a better approximation to the true intensities also in the case of  $\text{O}_2$ , as was shown by E. Fermi (*Physica*, 4, p. 340, 1924), but it remains an approximation. Besides, it is necessary to know how the system behaves in an external field, and as to molecules we know nothing certain about this point.

Accurate quantitative measurements of intensities of band lines do not exist. The results are, however, in good qualitative agreement with the observations. If an application of the rules of Burger and Dorgelo to band lines is justified, intensity measurements will be of very great value in determining the structure of band spectra.

A more detailed account will be given elsewhere.

G. H. DIEKE.

Instituut voor theoretische natuurkunde,  
Leyden, April 27.

### The Word "Australopithecus" and Others.

It has been stated by several critics that the word "Australopithecus" is a hybrid (Latin-Greek) term. I am indebted to my colleague Mr. T. J. Haarhoff, professor of classics in the University of the Witwatersrand, for the information that *pithecus* was a recognised naturalised Latin word in Rome. It was used by Cicero's own secretary Tiro and by other accredited writers, and more than a century before Cicero's time Plautus employed the diminutive *pithecium*. It is, therefore, not surprising that both of these words are to be found in a standard Latin dictionary, such as that of Lewis and Short. The still commoner *cercopithecus* is found in Pliny, Varro, Juvenal and Martial, to the last-named of whom (Book xiv. Epigram 202) we owe one of the most pleasing examples of the indiscriminate juxtaposition of the two words used by polished Romans for a monkey:

Callidus emissas eludere simius hastas  
Si mihi cauda foret cercopithecus eram.

"A monkey, cunning to avoid darts, hurled at me (the charge that)

I should be a tailed ape, had I a tail."

With regard to Homosimiidae versus Homini-simiidae, surely the word is parallel with any other double nominal term such as Pithecanthropus or Anthropopithecus. In defence of the introduction of the term Homosimiidae instead of Australopithecidae little need be said since the group intermediate between true apes and true men must have been man-apes and not all necessarily, much as one may anticipate the discovery, southern-apes.

RAYMOND A. DART.

### Photo-electric Cells for Colour-matching.

I NOTICE in your description of the exhibits at the Royal Society Conversazione in NATURE of May 23, p. 820, a brief mention of the method of colour-matching lamps by means of alkali photo-electric cells, shown by the National Physical Laboratory. As stated in the programme of the Conversazione, this method of colour-matching was first developed by the staff of the Research Laboratory of the General Electric Co., who kindly made for us the cells used, which are now being shown in the Royal Society's exhibit at the British Empire Exhibition. I shall be glad if you will allow me the opportunity of making this acknowledgment in your columns.

J. E. PETAVEL,  
Director.

The National Physical Laboratory,  
Teddington, Middlesex,  
May 26.

# The Cooling of the Earth.<sup>1</sup>

By Dr. HAROLD JEFFREYS, F.R.S.

THERE are strong reasons for believing that the earth was wholly fluid at an early stage of its history. My present topic is the manner in which such a fluid earth would solidify and afterwards cool to its present state.

The best known account of the solidification of the earth is that given by Kelvin. Most of the rocks that constitute the crust contract when they solidify. According to Kelvin, then, the first stage in solidification was the formation of a thin solid shell on the outside. But this shell was denser than the liquid interior, and therefore was unstable when floating on it. The shell therefore broke up and the pieces sank. A new shell then formed on the outside and the process was repeated, until the liquid was replaced by a sort of honeycomb; the cells filled with magma might become the seats of later vulcanism.

This account requires to be modified to allow for two facts. Pressure raises the melting point, and also the temperature of a rock material. Also the earth is not composed of a single material, but of several with widely differing densities and melting points. We wish to know how far these facts will modify the mechanism described by Kelvin.

Taking the former effect first, let us consider what would be the actual course of events in the solidification of an earth composed of a single rock material and cooling by radiation from the surface. Matter cooling at the surface would thereby contract and become denser than that underneath, and therefore would sink, its place being taken by other matter from below. Thus the whole would be continually stirred up. But when the matter descends it enters regions of greater pressure, and consequently is heated. The rise of temperature is estimated by L. H. Adams, of the Geophysical Laboratory at Washington, as somewhat less than 1° C. per kilometre of depth. So long as the earth remained fluid, then, the temperature in it would decrease downwards at this rate.

Now pressure raises the melting point of rocks to the extent of 3° C. for the pressure due to the weight of a kilometre of rock, much more than the effect of pressure on the actual temperature of a specimen of fluid. Thus, while the earth was fluid, the difference between the temperature of the fluid at any depth, and the melting point at the same depth, was greatest at the surface and least at the bottom. The temperature therefore reached the melting point first at the bottom, and solidification started there (at the centre of the earth, that is, since we are considering an earth of uniform composition). Cooling and agitation continued at higher levels, and the solid layer gradually thickened until it reached the surface. Thus the honeycomb structure would not be produced.

Coming now to the differences of material within the earth, we can exhibit the principal constituents in the accompanying table.

The materials are here arranged in order of increasing density. They probably form fairly continuous layers in the earth, the denser at the greater depths. The

first four are frequent at the surface, but the Femi is known only in deep-seated intrusions, and the nickel-iron alloy is only believed to occur deep down in the

Layer.	Typical Rock.	Specific Gravity.	Melting Point.	Chief Constituents.
Air		10 <sup>-3</sup>	-200°	
Water		1	0°	
Sal	Granite	2.66-2.72	600°-1000°	SiO <sub>2</sub> , Al <sub>2</sub> O <sub>3</sub>
Sima	Diabase, Basalt	3.0	1200°	SiO <sub>2</sub> , FeO, CaO, MgO
Femi	Peridotite	3.3	1400°	SiO <sub>2</sub> , MgO (in excess), Fe <sub>2</sub> O <sub>3</sub> , Fe <sub>2</sub> O <sub>4</sub>
Nife	Nickel-Iron	8.2	?	Ni, Fe

earth because some such material is necessary to account for the high mean density of this planet. The names Sal, Sima, Femi, and Nife are due to Suess; each combines in abbreviated form the names of two characteristic constituents of the material.

One of the first events in the formation of the earth was the settlement of the Nife to the centre. We know from the theory of the figure of the earth that its boundary is about 1400 km. down, so deep that it can have had no important effect in the evolution of the upper layers.

If the water of the ocean was originally in the atmosphere, in the form of steam, the pressure of its vapour at the earth's surface would be of the order of 300 atmospheres. It is known by experiment that at such a pressure melted granite and water mix freely. It is therefore probable that nearly all the water was initially within the crust, dissolved in the rock magmas. It is more doubtful whether the principal rock types could mix with each other when fluid. Experimental evidence shows that they could in some conditions, but their present mode of occurrence indicates that at some stage in the development a certain amount of separation took place. It is probable that a gradual solidification of the denser and less fusible rocks led to a concentration of the water in the granitic layer, and that much of it was extruded from the last itself when it solidified.

The solidification would start either with the Nife or at the bottom of the peridotitic layer, and would extend upwards as was described for a homogeneous earth. The liquid above would remain in adiabatic equilibrium until no further femic material remained liquid. The temperature anywhere in the solid portion would evidently be the melting point at the depth considered. Hence the rate of upward transmission of heat by conduction in the solid layer is calculable: it would be about  $1.5 \times 10^{-7}$  cal./cm.<sup>2</sup> sec. But the rate of loss of heat from the outside by radiation would be more like 1 cal./cm.<sup>2</sup> sec. Thus the liquid layer would go on cooling by radiation almost as if no heat was being conducted into it from below, until the temperature at its base reached the melting point of Sima, when the rocks of this type began to solidify. When the Sima was solid, further cooling led to the solidification of the Sal layer; at some stage of the process the water separated and an ocean formed.

As soon as the earth was solid at the outer surface, the great excess of the heat lost by radiation over that

<sup>1</sup> Based on a lecture delivered before the London Mathematical Society on April 23.

conducted from the interior would ensure that the temperature of the surface rapidly fell until the loss of heat from the surface nearly balanced that received from the sun. The sun was at that time probably radiating about as intensely as at present, so that the equilibrium temperature of the surface would also be nearly the present temperature. Thus the primitive solid earth would have much the same surface temperature as now, but a temperature equal to the melting point of peridotite was reached at, or a little below, the top of the femic layer, perhaps 40 kilometres down. Cooling to this stage probably took some thousands of years from the formation of the earth.

The cooling of the earth, from the stage just described, down to its present condition, was a much slower process. So long as the outer layer was liquid any cooling on the outside would lead to turbulence, and therefore the whole of the liquid layer would cool equally fast. But when the earth had become solid, conduction became the only agency available to redistribute its heat, and conduction is very slow. The beginnings of a quantitative discussion of the point were made by Fourier, who showed that if we have a uniform rod, infinite in both directions, and with initial temperature  $f(x)$  at distance  $x$  from a fixed point of the rod, the temperature at time  $t$  is given by

$$V = \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} f(x + 2qh\sqrt{t}) e^{-q^2 dq},$$

where  $h^2$  is the thermometric conductivity. In the earth the region is not infinite in either direction; but it is found to be a good enough approximation to suppose it infinite downwards and to treat the flow of heat as one-dimensional, since the depth where cooling is considerable is a small fraction of the radius. The other boundary condition is that the temperature at the surface is maintained constant. Lord Kelvin made the first important contribution to this problem, as to that of the method of solidification, though in this case also his discussion has needed much revision to bring it into accordance with later experimental knowledge. He supposed the temperature at all depths, 0 to infinity, to be uniform and equal to  $S$ , the melting point. The difficulty of the constant surface temperature was met by replacing the earth by a solid infinite in both directions, the temperature being antisymmetrical with regard to the surface. Thus subsequent conduction would keep the surface temperature constant, and Fourier's solution could be applied as it stood.

Kelvin's solution was

$$V = S \operatorname{Erf} \frac{x}{2h\sqrt{t}},$$

the symbols having the meanings already given. Erf is the Error function, defined by

$$\operatorname{Erf} \lambda = \frac{2}{\sqrt{\pi}} \int_0^{\lambda} e^{-q^2} dq.$$

Differentiating this and then putting  $x$  zero, he found

$$\left( \frac{\partial V}{\partial x} \right)_{x=0} = \frac{S}{h\sqrt{(\pi t)}}.$$

This equation was used by Kelvin to estimate the age of the earth. The left side is the rate of increase of temperature downwards at the present time, deter-

mined from observations in mines and borings. With modern data this is  $32^\circ \times 10^{-5}/\text{cm.}$ , and with  $S$  equal to  $1400^\circ$  and  $h$  as  $0.084$  c.g.s., the equation makes  $t$  equal to 27 million years.

The increase of temperature downwards would alter this equation slightly: its effect is to introduce into the temperature a term of the form  $mx$ , which does not change with the time. Allowing for this we find that the estimate of  $t$  needs to be increased to 33 million years.

These estimates, however, were found to need drastic alteration soon after the discovery of radium. Radioactive matter was discovered to be universally present in rocks, to such an extent that in an average granite it is generating  $10.1 \times 10^{-13}$  cal. per c.c. per second; the amount for a basalt is  $2.7 \times 10^{-13}$  cal. per c.c. per second. These amounts appear small, but then so is the loss of heat from the surface. The latter is about  $1.6 \times 10^{-6}$  cal. per square centimetre per second. Thus a layer of average granite 16 kilometres thick would account for all the heat leaking out of the earth. This remarkable result was obtained by the present Lord Rayleigh. That it demanded careful reinvestigation of the theory of the cooling of the earth was obvious; and some writers went so far as to deny that the earth is cooling at all. The situation, however, was never so serious as this. Either the total radioactivity is less than that of 16 km. of granite, or it is greater. If it is less, the earth is cooling to some extent, though less than the simple Kelvin theory indicates; if it is greater, it is impossible to explain why the amount of heat being conducted out of the earth is as small as it is, for the heat generated must be going somewhere.

A way out of the impasse was found by Dr. Arthur Holmes, in a series of papers in the *Geological Magazine* for 1915 and 1916, which have not yet attracted from physical writers the attention they deserve. Taking the extreme case of no cooling, so that the temperature within the earth is now everywhere steady, he worked out the depths of rock of various types needed to give the observed surface temperature gradient, and hence the temperatures at various depths. He found that if the radioactive layer was average granitic rock, the temperature within the crust could nowhere exceed that at the surface by more than  $300^\circ$ . Such a temperature is quite inadequate to explain the occurrence of volcanoes and igneous intrusions within the continents, and points definitely to another source of heat, which it is natural to refer to the primitive store.

Holmes therefore assumed a cooling earth, with radioactivity falling off exponentially with the depth; the mathematical solution of this problem had been given by Ingersoll and Zobel, but not applied to the actual conditions of the earth. If the rate of generation of heat per unit volume is  $Ae^{-ax}$ , it was found that

$$\left( \frac{\partial V}{\partial x} \right)_0 = m + \frac{S}{h\sqrt{(\pi t)}} + \frac{A}{ak} \left( 1 - \frac{1}{ah\sqrt{(\pi t)}} \right).$$

This equation contains now two unknowns,  $t$  and  $a$ . Thus it can no longer be used for finding  $t$ ; but that does not matter, because radioactivity gives us an independent determination of  $t$ . The disintegration of uranium produces lead at a known rate, and hence the analysis of a uraniferous rock makes it possible to estimate the time elapsed since that rock crystallised.

By this method the age of the oldest rocks known has been determined as 1400 million years, and it is probable that the whole age of the earth is about 1600 million years. With this extra datum we can find  $\alpha$ . It turns out that radioactivity at a depth of 13 km. must be  $1/e$  (that is, 0.37) of what it is at the surface, that at 26 km.  $1/e^2$ , and so on. On this basis it is found that the differences between the present temperatures at various depths and the melting points of peridotite at the same depths are as follows :

Depth (km.):	0	37	74	111	148	185	222	259	296	333	370	444	518	592
Temperature differences (degrees C.):	1400	940?	830	710	600	510	420	340	280	210	170	95	50	25

Below 600 km. or so the cooling is inappreciable. The cooling at depths of 200 to 300 km. is not so great as to forbid occasional softening of the more fusible constituents of the Femi, so that the existence of vulcanism is consistent with these estimates.

I have performed the corresponding calculations for another hypothesis differing as far as possible from that

of Holmes ; namely, I supposed the radioactivity uniform down to a finite depth and zero below that depth. The effect of the change is not great : the cooling at all depths is increased by about 16 per cent.

The above calculations are based on numerical data differing somewhat from those used by Holmes, and also from those used by myself in previous work. Previously I used as the primitive surface temperature the melting point of basalt,  $1200^\circ$ , seeing that it was the deep-seated rocks whose initial temperatures would have the greatest influence in determining present temperatures. But L. H. Adams,<sup>2</sup> in a recent re-discussion of the whole matter, has pointed out that I did not go far enough, and adopts  $1400^\circ$  as his standard melting point ; this datum has been used above. At the same time he has made an allowance for the difference between the conductivities of rocks at different depths. The effect is to increase the amount of radioactive material and reduce the cooling, but the general trend of the results is not violently changed.

<sup>2</sup> Jour. Wash. Acad. Sci., 1924.

### The Royal Academy Exhibition.

IN a little book on "The Revolutions of Civilisation," with abundant illustrations of the arts of many ages, Sir Flinders Petrie has sketched out a sequence of rise and decline of civilisations in eight periods from the dawn of history, six of them between 6000 B.C. and A.D. 2000. It is through the arts that the sequence is manifest : the several arts keep an order of precedence, they reach in turn a maximum of development ; and in turn decay. In each period sculpture is the first of the arts to reach its maximum phase, followed by pictorial arts and then in turn by literature, mechanics, and finally by wealth. So also, in each period, the first signs of decay are manifest in sculpture ; the decay of pictorial arts comes next. Medieval civilisation developed its maximum phase of sculpture in the thirteenth century, of painting at the end of the fourteenth, of literature at the end of the fifteenth ; we are now in the maximum phase of mechanics, and all we have in prospect before our period goes out and the ninth becomes dominant is a maximum of wealth.

Suppose a visitor properly imbued with these ideas of revolutionary civilisation should find himself among the Royal Academy pictures of 1925, with room to see, and leisure to think about, the fourteen hundred items of the exhibition, what impression would he get ? What would he think of sculpture which already showed signs of decadence four centuries ago ? It is represented by reliefs, as 1273, *The Late Bishop of Hereford* for his Cathedral, by Allan Wyon, recumbent statues of *Lord Kitchener* in marble (1381) for St. Paul's, W. Reid Dick, and *The Late Bishop of Coventry* in bronze for his Cathedral (1377), by Sir Hamo Thornycroft, R.A., many figures, busts and statuettes, and some really convoluted animals, *Wild Swans* (1222), *Eagle, Lynx, and Hare* (1223), by the Danish sculptor Holger Wederkinch. Is a recumbent statue the imitation of a bygone habit of centuries ago or a step in the progress of the realisation of an art which also strives to represent action, as in a bronze *Atalanta* (1414) by Sir Bertram Mackennal ? After he had assigned the position of sculpture, between the failing light of the eighth period and the

dawning of the ninth (making what allowance is necessary for "copying," with which Sir Flinders Petrie declines to concern himself), what would he think when confronted with 477, *Sir Donald MacAlister of Tarbet*, as portrayed by Maurice Greiffenhagen, R.A., or 79, *A Street Accident*, by Glyn W. Philpot, R.A., or 340, *The Soul's Journey*, according to Mrs. A. L. Swynnerton, A. ? How would he relate them to the golden age before the cinquecento ? What, anyway, could the student of civilisation have said if 160, *Man Versus Beast (Paris)*, Sir William Orpen, R.A., happened to have been unearthed from an Egyptian tomb instead of being exhibited as a novelty in a London gallery ?

It is a well-arranged exhibition : the oil paintings, which number only 631, are hung within comfortable view, mostly in not more than double rows. These are supplemented by 407 water colours, miniatures, drawings, engravings or etchings in the South Rooms, 174 architectural drawings and 207 sculptures.

One gets the impression of alternations of portrait and landscape with very few historical or subject pictures, more uniformity of excellence and fewer striking exceptions than usual. There are, once more, a number of examples of brilliance of illumination by La Thangue obtained by juxtaposition of light and shade : 42, *Amalfi Vines* ; 84, *A Provençal Flock* ; 141, *The Thorn* ; and 175, *The Trout*. There are some efforts of a similar character not nearly so successful : 305, *Jack, Jill, and Peter*, Dorothea Sharp ; 407, *A March Morning*, Harry Fidler ; and better than these 537, *Eucalyptus Avenue*, Mary H. Carlisle. There are also striking examples of moonlight brilliance by the juxtaposition of iridescent colours ; 14, *Silver Moonlight*, and 129, *The Ebbing Tide*, Julius Olsson, R.A.

For the spectator, whose days belong to science and to whom the technique of art is a mystery, the landscapes naturally afford more food for reflection than the portraits ; and the comparative uniformity easily leads to thinking about the colour schemes of Nature, as expressed by different artists. There is a whole gamut of variation between the blue middle distance and

red background of 150, *Evening Glow on Rosengarten*, by Adrian Stokes, R.A., and the colourless grey whiteness of sheep in 252, *A Blizzard*, by Joseph Farquharson, R.A.

All Adrian Stokes's pictures are indeed notable for their colour scheme; 7 and 18 present beautiful contrasts of yellow and crimson foliage with the blue vistas of distance in Italy, whereas in 229, *Green Haunts*, an English forest, green is everywhere, only relieved by patches of sunlight on a somewhat ruddy path. One can indeed classify the landscapes by their blueness, their redness, or their whiteness, and can speculate as to how far any differences are due to idiosyncrasies of colour vision or to a true appreciation of the fact that clouds of the very smallest kind of particle in the atmosphere are blue to look at, but red to look through; while clouds of larger particles are white to look at and grey to look through. So, in Italy, as already noticed, or in Spain, 570, *Among the Mountains*, Christopher Williams, where particles are very small, made perhaps of the finest dust or of wood smoke, distance is blue and setting suns are red, whereas in the Western Highlands, where particles which are not considerable water drops are scarcely to be found at all, distance is colourless and sunsets are practically white. Even in Spain, 117, *Bridge at Toledo*, Oliver Hall, A., the grey is scarcely to be called blue.

The Exhibition offers many suggestive examples of these various points of view. As white or grey pictures, 8, *Morning Light*, Clewin Harcourt; 12, *Waterloo Bridge, November Dawn*, Algernon Newton; 39, *Blythburgh from Henham*, B. Priestman, R.A.; 51, *On the Eastern Rother*, P. H. Padwick; 52, *The Bathers' Pool*, Algernon Talmage, A.; 111, *The Woodland Way*, W. W. Oules, R.A.; 169, *Evening, Trepied, Pas de Calais*, Sir H. Hughes-Stanton, R.A.; 187, *Kilchurn Castle, Loch Awe*, Sir D. Murray, R.A.; 240, *King George V. Dock*, W. L. Wyllie, R.A.

There is blue but grey blue, very true in tone, in 69, *The Farm on the Hill*, Arnesby Brown, R.A.; 275, *Himalayan Snowfield*, C. W. Bion, has grey blue; 472, *A Bule Hill Far Away*, Sir D. Murray, R.A., a very grey blue. There are blue distances in 292, *Blossom Time*, F. F. Foottet; 293, *Hoar Frost*, W. H. Adams; 631, *The Valley of Clitunno*, Freda Marston. So blue becomes more pronounced until 553, *The Blue Lake*, Sydney Lee, A., is almost incredibly blue. 110, *The Fountain of Neptune*, by the same artist, has the deepest of blue for a background; so has 130, *Miss Pearl Hood*, a portrait by Greiffenhagen. 596, *Almost Night, Venice*, Terrick Williams, A., is all blue; that must

presumably be a question of colour vision. J. C. Moody, in 92, *Into the Sun's Reflections*, colours the nearest black post blue; that must also be similarly classed if the blue of blue smoke is what physicists suppose it to be.

Red is more rare: it is the most transient of atmospheric colours except the green of the departing sun; such examples of red as there are are not very convincing.

Painters are still inappreciative of certain proprieties about clouds; some types are appropriate to early morning and others to afternoon and evening. A lapse in this respect, 159, *A Summer Morning*, George Clausen, R.A., gives the impression of restlessness that one feels before a thunderstorm, always a restless phenomenon. A similar feeling comes from the sky and lighting in 618, *The Bathers, Pas de Calais*, and other pictures. Something impels an artist to throw some sort of action into the sky, hence one finds thunderstorms "standing where they ought not." On the other hand, there is a beautiful English restfulness about 58, B. Priestman's *Lock Pool*.

Of the portraits the stark apparition of Sir Donald MacAlister has already been hinted at; an easily recognisable portrait of Lord Rayleigh, 211, by Melton Fisher, R.A., is not far on one side from a less easily recognisable portrait of the Master of Sempill and his wife; or, on the other side, from one of Lady Rayleigh, 556, by W. W. Russell, A., not quite so reposeful. Sir Humphry Rolleston, 260, by George Henry, R.A., comes freshly before us as the new Regius professor at Cambridge. The president of the Institution of Civil Engineers is there, 186, by Stanhope Forbes, R.A., the Deputy Master of Trinity House, 245, by R. G. Eves, and a number of portraits of doctors of various academic faculties. That brings us back to wondering where in the sequence of the revolution of civilisation clothes ought to be put. Are fine clothes or no clothes a sign of civilisation or are they not? And if they are, have we reached the zenith? Are we approaching it or have we passed beyond it to a period of decay? Neither sculpture nor painting in the Academy will give a conclusive answer in the year 1925, though both may give cause for thought about it. Without doubt, if they are not mere echoes of a loftier age and are, indeed, real flowers of the artistic genius of the twentieth century, 139, by Sir William Orpen, R.A., and 102, by Sir Arthur Cope, R.A., and not a few others, will suggest to anthropologists that the sartorial art of the eighth period must be at least very near its climax, for even Solomon in all his glory was not arrayed like some of these.

### The University Celebrations at Pavia.

(FROM A CORRESPONDENT.)

WHEN is a university not a university? That is the riddle set to the philosophic historian by the spirited claim of Pavia to be the oldest university of Europe. The answer mostly given is *not* before the twelfth century, if it was then when the name *Universitas*, i.e. of students from different nations and of different subjects, began to displace the older term of *Studium Generale*, which lingered on in Italy for many centuries. But the distinguished writers on medieval law and history who have made Pavia well

known in recent years, especially the present Rector, Prof. Arrigo Solmi, seem to be justified in maintaining that when a summons is issued by a great monarch, the greatest of his day, to a number of towns in a wide area, to centralise their efforts in all studies beyond school-level in a single spot under the direction of one eminent teacher and his colleagues, whom the said monarch has expressly invited and established, it becomes a question of name rather than fact whether we call the result a university or no.

History, in fact, has repeated itself many times in such matters. When Napoleon had freed Piedmont from the Austrians, he invited to Pavia in 1805, at the advice of a scholarly nobleman of Milan, a number of eminent professors, of whom Alessandro Volta, a founder of electrical science, was the greatest; but in doing so he only did for Pavia in his day what the Emperor Lothair, whose throne and title Napoleon claimed, had done by his famous proclamation, or *Capitulare* as he called it, in the year 825; for in that year Lothair established the well-known Irish monk Dungall in Pavia and bade all the chief cities of the western half of North Italy, including Genoa, Turin, and Milan, to send their students and teachers to Pavia. The curious may read of Dungall and his far-seeing letter in answer to Charlemagne's question about certain eclipses of the sun, in the "Dictionary of National Biography"; and that Pavia has worthily maintained the tradition of liberal and progressive study which he there set up, cannot be questioned.

The debt which Pavia owed to Ireland, she repaid to England in the person of the great divine and lawyer Lanfranc, who, beginning as a student and teacher of Pavia, became head of an abbacy in Normandy and was chosen by the Conqueror as his chief adviser in England, and made the first Archbishop of Canterbury under Norman rule. His work there reflected, we learn, the conspicuous service which Pavia itself rendered to European progress, in combining and harmonising the established principles of Roman and Canon Law with the comparatively barbarous but deeply rooted customs of northern Europe; a fusion of which the Feudal system had been itself a product. The central ceremony of this "eleventh centenary" of the University of Pavia was the unveiling by the King of Italy of a monument to the memory of Lanfranc in one of the courts of the University. This is a seated bronze figure of a robust and shrewd-looking but also beautiful damsel holding a scroll labelled *LEX*, personifying Lanfranc's contribution to the civilisation of Europe.

This spirit of conciliation and harmony between friends, neutrals, and even former enemies, from without and from within, was conspicuous in the recent festival. Germany, Hungary, and Turkey, no less than Switzerland, Spain, Holland, and Scandinavia, sent representa-

tives to join those from the allied countries, Czecho-Slovakia, Poland, France, Belgium, Esthonia, the United States, and a particularly numerous contingent from the British Empire (among them Sir Martin Conway, Prof. Edmund Gardner, Prof. Alfred Parr, and Prof. Moffat of Madras). But from the Italian point of view the harmony of different sections of Italian feeling was new and most remarkable. A new university banner presented by ladies of the town was blessed by an archbishop and a cardinal who conducted a special Mass; a proceeding which could scarcely have happened in any Italian university since Napoleon's time. This same cardinal is a rugged and noteworthy personality, Archbishop Maffi of Pisa, whose general support of the present government has been varied by his courageous and dignified protests against ill deeds like the murder of Signor Matteotti, for which it is generally assumed that some section of the Fascisti was responsible. Yet he appears on the same platform with the Minister of Education who bore Mussolini's express good wishes, and expressed a lively interest in the record of the University, the work of jurists like Buonfiglio and Bagelard, Latinists like Lorenzo Valla, and men of science from Volta to the venerable physiologist, the Nobel prizeman, Prof. Golgi, who was present at the ceremony.

The admirable address of the Rector was a model of precision and enthusiasm, tracing in the work of Pavia the combination of "*Scienza*" and "*l' Idealità*," scientific method and humane ideals. Only one detail must be here added, significant of the many-sided activity of the University. Practically all the wine of the district, wine of many qualities and colours, but all (by common consent of the visitors) excellent in their kind, is produced by a co-operative union of some 3000 cultivators; and the chairman of the union is the professor of botany. He was also until recently an anti-Fascist member of the Italian parliament; and some of his supporters expressed to the present writer a pleased surprise that he was allowed to continue unmolested both his professorial and his agricultural work. It may be foretold with some confidence that the immediate future of Italy has many such pleasant surprises in store; for the spirit of the now renascent Italy is precisely that which has governed and inspired the celebrations at Pavia.

### Obituary.

SIR WILLIAM FLETCHER BARRETT, F.R.S.

THE death of Sir William Barrett, F.R.S., on May 26, at eighty-one years of age, removes one who dates back to a period in physics long antecedent to all the recent advances—the period of Wheatstone and Balfour Stewart and Tyndall. He never pretended to follow the recondite mathematical and dynamical investigations of last century, typified by the great names of Stokes and Thomson and Tait. The original discoveries in physics which he himself made concerned such things as—sensitive flames, which he first observed while working in the 'sixties on sound in Tyndall's laboratory at the Royal Institution; some alloys of iron, especially a useful one called stalloy, which he claimed to have announced in 1899; and the odd behaviour of iron at or near the magnetic

critical point. In this last phenomenon, a hot iron wire under longitudinal strain not only suddenly expands but also rises in temperature, giving a momentary glow which he called calorescence, since he regarded it as an example of a rise in the refrangibility of emitted radiation—presumably by molecular or atomic rearrangement—in contrast to the lowering of refrangibility (or what we now call frequency) so well elaborated by Sir G. G. Stokes under the name fluorescence.

As a popular lecturer and teacher in the experimental phenomena of physics Barrett was very successful, and he must have often contributed welcome information at meetings of the Royal Dublin Society.

His first and only academic chair was at the Royal College of Science in St. Stephen's Square, Dublin, which he assumed in 1873 and vacated in 1910, during

which period it may be safely said that the College which he faithfully and effectively served underwent several threatenings, if not vicissitudes, thereby causing him anxiety which he did not hesitate to express.

The main interest of Barrett's middle and later life lay in the exploration of obscure human faculties, such as were not receiving attention from the majority of scientific men and were often cold-shouldered as mere surviving superstitions. He felt that in this unlikely milieu there lay hidden a grain of truth, which he set himself pertinaciously to find and enthusiastically to exhibit to others. He was in frequent touch with such other explorers in unpopular regions as Alfred Russel Wallace and William Crookes, and he never doubted that between them they had unearthed some genuine phenomena, which, though sometimes bizarre and apparently incredible, would ultimately be accepted by science, and might, he hoped, prove of moment to mankind. It was in this faith that he worked, and stimulated work in others. How far he was justified, posterity will know better than we. It must be made quite clear that many men of science deny all these asserted phenomena, and apparently do not consider them worthy of serious examination. That care and caution is necessary in such a region is well known, but even now there are several who have little or no doubt that a faculty of communion or communication between individuals exists which is independent of the recognised organs of sense; and of this faculty Barrett considered that he might hereafter be regarded as perhaps the chief discoverer. So far as I know he had no theory on the subject; he was content with observing and recording the facts, observed under what he considered adequate precautions against deception. He read a paper to the British Association at Glasgow in 1876 on what was later called telepathy, but the feeling of improbability about the reality of such a faculty was so strong that its publication was suppressed. He did, however, get a letter published in *NATURE* for July 1881, shortly before the foundation of the Society for Psychical Research.

Another inquiry, which he carried out in Dublin, related to the asserted Reichenbach phenomena, *e.g.* the sensitiveness of certain people to magnets. These experiments, though carefully conducted, led to no conclusive result, when all opportunity for suggestion and all normal clues were eliminated.

On yet another faculty he became quite an authority, namely, the faculty for finding water or other things by means of an unconscious physiological reaction, demonstrated usually by the twisting of a rod held in the hand. The possession of such a faculty can be pretended or imagined, but Barrett came to the definite conclusion that in certain persons it was real, and could be utilised.

Finally, Barrett enlisted the interest of many distinguished scholars, both in the British Isles and in the United States, in the search for unrecognised but traditional human faculties; and he had a stimulating hand in founding the Society for Psychical Research in London, with a branch in Dublin; and also a somewhat similar society in America, the latter being at one time presided over, no doubt in a reasonably incredulous spirit, by no less a person than Simon Newcomb; who probably held the opinion that

everything might legitimately be explored, and if necessary condemned, in the interests of truth.

On the personal side it must be admitted that some people found Barrett's quick eager manner unrestful, but every one recognised the transparent honesty and simplicity of his character, and could not help admiring the keenness with which, right up to the end, he was ready to undertake any labour to get phenomena properly observed and recorded. Correspondents from all over the world must have sent him tales of extraordinary happenings, and a winnowed selection of these he contributed from time to time to the Proceedings of his special Society. With its slow and cautious methods he was often impatient, urging greater enterprise and activity, but he accepted its presidency for a year, and continued on its Council to the end.

Barrett's domestic life was of the simplest. Through most of the years his sister kept house for him, until 1916, when, to his extreme happiness and content, he married the distinguished surgeon and gynaecologist Mrs. Florence Willey, M.D. It was at her house that he died, through heart failure, in full possession of his faculties except his sense of hearing. He loved life, but, as his books show, he regarded the continuance of existence, in some still personal form, as almost if not finally demonstrated. Death did not seem to him an interrupter of mental continuity.

So has passed over one who served truth to the utmost of his ability, whose researches brought him into personal contact with all sorts and conditions of men, one who was not deterred by ridicule or opprobrium from following such clues as he could find; yes, and if his chief interest is ever universally recognised as well founded, one who will be hailed and respected by posterity as a pioneer.

OLIVER LODGE.

FATHER A. L. CORTIE, S.J.

FATHER ALOYSIUS LAURENCE CORTIE, S.J., who died on May 16, was born in London on April 22, 1859. He had thus attained the age of sixty-six years. His cheery genial ways left the impression of his being a much younger man, and he will be mourned by a wide circle of friends who enjoyed his companionship in his merry moods and valued it in his more serious moments. He was educated at Stonyhurst, and having joined the Society of Jesus at Roehampton in 1878, he was ordained priest in 1892. For thirty years, with but little intermission, he was on the staff of Stonyhurst College teaching physics and mathematics, and he was also director of music for nineteen years. He was a very popular teacher, and the hold which he gained on the affection of the boys was maintained throughout his life, for he continued by correspondence in touch with his old pupils in all parts of the world. No Stonyhurst gathering was considered complete without Father Cortie. His songs and his quaint stories were equally welcome. His quick sense of humour enabled him to pick out many a local episode, which he would recount in the Lancashire dialect to the great amusement of his hearers. He was in great demand as a popular lecturer on astronomical subjects, and as his humorous touches seemed to give almost as much amusement to himself as to his audience, his call on their interest and sympathy was irresistible and met with immediate response.

Father Cortie took a large share in the work of the Stonyhurst College Observatory during the directorship of Father Sidgreaves (1890-1919), and he became director in 1919 on the death of Father Sidgreaves. His astronomical work was in large measure connected with the relation between the phenomena of sunspots and terrestrial magnetism, and he contributed many papers to the Royal Astronomical Society and to the *Astrophysical Journal*; among them were a number relating to stellar spectra, a subject to which Father Sidgreaves had devoted much attention.

Father Cortie, carrying on a tradition started by Father Perry, took part in several expeditions to study the phenomena presented in total eclipses of the sun. He travelled to Vinaroz (Spain) in 1905, to Vavau, Tonga Islands, in 1911, and to Hernösand (Sweden) in 1914, to make observations of eclipses. He had but poor luck in the earlier expeditions, but in Sweden he observed the eclipse "in absolutely perfect weather conditions" and obtained not only valuable spectroscopic observations but also beautiful photographs of the corona, one of which is well reproduced in the Report of the Stonyhurst College Observatory for 1914.

In 1891 Father Cortie was elected a fellow of the Royal Astronomical Society, and for many years he served on the council of the Society. He was an active member of the British Astronomical Association, which he joined in 1894; for eleven years (1900-1910) he was director of the Solar Section of the Association,

and in that capacity he was responsible for many reports on solar work. He was president of the Manchester Astronomical Society since 1911. In 1922 he was made a member of the International Astronomical Union's Committee on the Solar Atmosphere and attended the meeting of the Union at Rome in that year. After the meeting he received an honorary degree at Padua on the occasion of the seventh centenary of the foundation of the University. Quite recently he had been elected president of the Manchester Literary and Philosophical Society.

WE regret to announce the following deaths:

Dr. A. G. Butler, late senior assistant keeper of the Natural History Museum and distinguished as an entomologist and ornithologist, on May 28, aged eighty years.

Dr. John Mason Clarke, State geologist and palæontologist and director of the State Museum and Science Division of the Education Department, New York, a fellow of the National Academy of Sciences, Washington, and foreign member of the Geological Society of London, sixty-eight years of age.

Prof. Giovanni Battista Grassi, Senatore del Regno, distinguished for his work on the transmission of malaria, on May 4, aged seventy-one years.

Prof. C. K. Wead, an examiner in the United States Patent Office and formerly professor of physics in the University of Michigan, who was known for his work on physical and musical acoustics, aged seventy-six years.

### Current Topics and Events.

THE Rowett Research Institute, Aberdeen, for the investigation of problems of animal nutrition, has been fortunate in receiving funds from private sources. Two years ago Mr. W. A. Reid, of Aberdeen, endowed the Library and Statistical Department. The Institute has now received a gift of 10,000*l.* from Mr. Duthie Webster to support the work of an experimental stock farm. Mr. Webster, who is an Aberdeenshire farmer, is the nephew of the late Mr. William Duthie, of Collynie, who earned world-wide fame as a breeder of beef cattle. The farm is being established in accordance with recommendations made by Prof. T. B. Wood, Director of the Animal Nutrition Institute at Cambridge, and Dr. J. B. Orr, Director of the Rowett Research Institute, in a joint report which, at the request of the Agricultural Council, was drawn up and submitted to the Ministry of Agriculture and the Board of Agriculture for Scotland. One of the sections of that report emphasised the desirability of having in Great Britain one or more experimental stock farms where the results of research work, which appeared of probable economic value, could be tested on a large scale, under practical conditions. In the report it was recommended that such a farm should be established in connexion with the Rowett Research Institute.

THE scheme, which is now being carried out at the Rowett Research Institute, makes provision for departments dealing with milk cows, beef cattle, pigs, sheep and poultry, and it is intended that each department will have as its head a worker who, after having been trained in research in nutrition, will devote

himself entirely to the study of practical problems connected with the nutrition of the kind of farm animals in his department. The establishment of this experimental stock farm in connexion with the Rowett Research Institute is an important development in the scheme of research in agriculture, promoted by the Development Commission some years ago. It will enable the results of work, the full significance of which can only be understood in scientific circles, to be presented in a form intelligible to those engaged in the industry of animal husbandry. The results of large scale-feeding experiments carried out under practical conditions, should be of interest not only to stock breeders but also to those engaged in research, whose experimental work has to be confined of necessity to tests with small laboratory animals.

THE recent Conference on the Standardisation of Plate Testing Methods, inaugurated by the Royal Photographic Society, appointed an influential committee to consider its work in detail and to draw up a report for submission to the coming Paris International Congress on Photography. The report of the Committee is published in full in the Society's Journal for June. The Committee recommends a standard illumination of 4-metre candles obtained by the use of a 15-20 c.p. standardised metal filament lamp used at a colour temperature of 2360° K., this having the same colour as the Eastman Kodak acetylene flame. For exposure it recommends a non-intermittent exposure mechanism and a time scale, intensity remaining constant. When uniformity in the developer is desirable, it recommends the pyro-soda formula of Hurter and

Driffeld, but of three-quarters the strength prescribed by them. The Committee recommends development in a dish, and the use of a brush to produce an efficient turbulence over the whole surface of the plate. For measuring the densities it advises the use of a definite instrument and a definite opal glass in contact with the density being measured. The pieces of opal glass should be standardised at some such institution as the National Physical Laboratory. For the interpretation and statement of results a set of curves plotted in the usual way for at least three periods of development is recommended. The effect of fog needs further investigation. The under-exposure portion of the curve should be given separately, and an illumination of  $1\frac{1}{10}$  m.c. is advised for work in this region, and it may be obtained from the standard light source by reflection from a magnesium oxide screen. It is hoped that these conclusions may form a basis for the standardisation of plate-testing methods as discussed at the Paris Congress.

PROF. F. A. F. C. WENT, professor of general botany in the University of Utrecht, lectured on "Modern Conceptions of Light Stimuli in Plants" at the Imperial College of Science and Technology, South Kensington, on May 25. In the course of his address, Prof. Went stated that investigations which have been carried out during the last twenty years in Holland and elsewhere had cleared away many of the old conceptions concerning phototropic curvatures of plants. The work of Blaauw, Arisz, and Koningsberger were worthy of mention in this regard. It was discovered by Blaauw that a certain quantity of light—expressed in metre-candle-seconds—is necessary to obtain a curvature in oat seedlings or the sporangiophores of *Phycomyces*. Arisz made exact measurements of light-quantities and brought evidence against the view commonly held that perception and reaction are distinct processes. Moreover, he showed that when a plant is illuminated from two different sources, the curvature resulting is determined by the addition or subtraction of the two separate reactions. From this it seems probable that the so-called "tonus" is a question of the summation of reactions, not of perception. Blaauw's well-known explanation of growth curvatures as due to the light-growth-reaction has been confirmed by Koningsberger by means of a very accurate recording auxanometer. In future it will be necessary to work with light of which the energy value is much more accurately measured than in metre-candle-seconds. It is probable that in phototropic responses some substance of the nature of a hormone, such as has been demonstrated in relation to geotropic curvature, will later be detected. It is doubtful whether the use of the word "stimulus" is now of much value in phototropism.

A NEW development at the Royal Botanic Gardens, Kew, is a house for the display of plants of botanical and educational interest. The special display at present consists of *Calceolarias*. *C. cana* is a small hoary-leaved species from Chile with violet-scented flowers, and the hybrids which have resulted from it show the hoary leaves of *C. cana*, while the flowers

show a wide range of colours from white through yellow to a deep purple red. The South American *Calceolarias* have the characteristic pouched flowers, but there are four exceptional species, with open helmet-shaped flowers, two of which occur in South America, *C. violacea* and *C. punctata*, and two in New Zealand, *C. Sinclairii* and *C. repens*. An exhibit of *Petunias* has also been arranged showing the development of the garden *Petunia* from the two wild species from the Argentine and Uruguay, namely *P. integrifolia* (syn. *P. violacea*) and *P. nyctaginiflora*. *P. integrifolia* is better known as *P. violacea*, and was received as such by the Glasgow Botanic Gardens during 1831, seed being sent by John Tweedie, then resident at Buenos Aires, and a hybrid with *P. nyctaginiflora* was raised during 1834. It was lost to cultivation for many years until 1916, when Kew reintroduced it, after several failures, through the kind offices of the late Mr. C. E. R. Rowland, then Vice-Consul at Monte Video. An interesting new South African Composite, *Venidium Wyleyi*, is also exhibited, which has been raised at Kew from seed received from Miss Wilman of Kimberley, a well-known South African botanist. The exhibits will be changed from time to time throughout the year.

SHOWERS of fish have from time to time been reported, and the following account of one that occurred in the Hardoi district of Oudh, as given in a letter from the Deputy Commissioner of that district, has been forwarded to us by Mr. C. A. Silberrad: "The local calamity was of a new type. It happened in an area 200 yards wide and three miles long in the northern part of this district. One evening in April 1924 a whirlwind rose in a small area. It advanced to the east, and as it advanced it increased in velocity and force. All the trees—big huge trees—were uprooted and carried long distances, not dragging on the ground but flying overhead. Fish in a 'tank' [*i.e.* reservoir or large pond] which came in the way were blown out and two villages were destroyed. About 45 men were killed or injured, and 150 cattle destroyed." A similar occurrence is recorded in the April-June issue of the *Australian Museum Magazine*, where it is stated that the Director of the Australian Museum, Sydney, recently received a bottle containing three small fish, which, according to the accompanying letter from Mr. F. Richards, of Gulargambone, New South Wales, "were found in the gutters and on the streets here, with hundreds of others after recent heavy rain." Examination of the fish showed they were small freshwater gudgeons (*Carassioys klunzingeri*), which are very common in streams and water-holes in western New South Wales and Southern Queensland.

AN interesting illustrated account by T. W. Jones of the life and work of Dr. Thomas Beddoes appears in April issue of *Science Progress*. Beddoes' greatest discovery was Humphry Davy, who was the first medical superintendent of his "Medical Pneumatic Institution" at Clifton. Beddoes was born at Shifnal in Shropshire in 1760, and at the time of

graduation in classics at the age of nineteen, he had acquired considerable manipulative skill in pneumatic chemistry and was conversant with the work of Priestley, Cavendish, Lavoisier, and Scheele. He studied medicine and anatomy in London and, later, in Edinburgh. After a continental tour, in which he met Guyton de Morveau and Lavoisier, he accepted the post of reader in chemistry at Oxford. Beddoes became very popular here and spent the happiest years of his life; rash political views, however, caused him to resign in 1792. He had published translations of Bergman's "Elective Attractions" and Scheele's "Chemical Essays," amongst many other things, and also a digest of the work of Mayow. Beddoes now set up a practice, still continuing, however, his private research. His published work of this period is voluminous; most of it is medical in nature, but there is a "classification of chemical substances according to their principles," which he proposed. Much of Davy's earlier work was inspired by Beddoes, and was carried out under the latter's direction, *e.g.* the work on nitrous oxide which brought about Davy's promotion to the Royal Institution.

METEOROLOGICAL reports by wireless telegraphy for Great Britain and the countries of Europe and North Africa are dealt with by the Meteorological Office, Air Ministry, in a new edition of official publication, M.O. 252. The third edition of the work now issued consists of 134 pages, which, compared with 84 pages in the first edition issued in 1922, illustrates the immense development of wireless now in progress. A frontispiece shows the area covered by wireless weather messages employed in the Daily Weather Service of the British Isles, from which messages are regularly received by the Meteorological Office of the Air Ministry. The area embraces nearly the whole of the northern hemisphere. To obtain observations from the entire network of observing stations, most or all of the national issues must be intercepted, but the whole area may be approximately covered by utilising only the international collective messages issued by Great Britain, France, Germany, and Russia. Most issues can be received in the British Isles by the use of quite modest receiving apparatus. Details of the meteorological messages transmitted by each country are given on a uniform plan. The reports and times of the messages are made perfectly clear. The international codes are given of reports from land stations, reports from ships at sea, abbreviated reports giving a synopsis of the meteorological situation over the continent, with much detailed information of general application for weather study. Details of the particulars of the messages from different countries are given up-to-date according to information available on February 14 of the current year, and emending notices will be issued as alterations are required. Such notices will be issued free until a new edition is ready, on application to the Director of the Meteorological Office. The work is published by H.M. Stationery Office, price 3s. 6d. net.

IN order to study the possibilities of routes through central Africa, particularly between French Equa-

torial Africa and the East coast, Citroën Cars Limited has sent a large motor expedition across the continent. From Algeria the expedition crossed the Sahara to the Niger river, and then by Lake Chad to Banghi on the Ubanghi, a tributary of the Congo, which form the southern frontier of French Equatorial Africa. After a deviation to the little-known north-eastern part of the Ubanghi-Shari territory, a return was made south to Stanleyville on the Congo. From there the route was north-east through the Haut-Uele district, and eventually to Kasenyi on Lake Albert, which was crossed to Butiabwa. The route then lay south-east to Entebbe, across Lake Victoria and to Tabora. At Kampala one party branched off for Mombasa, and at Tabora another party turned west to cross Lake Tanganyika, and ascended the Lualaba valley through the Khatanga region and Rhodesia to Cape Town. The main expedition from Tabora was to proceed by Lake Nyassa and Blantyre to Beira. All the parties were to reunite at Mayunga on the west coast of Madagascar and cross the island by Antananarivo to Tamatave. Thus the whole of French Africa will have been traversed by motor car.

At the annual general meeting of the Institute of Physics, held on May 25, Sir William Bragg was elected president in succession to Sir Charles Parsons, whose term of office expires on September 30. Major C. E. S. Phillips was elected to succeed Sir Robert Hadfield as treasurer. The annual report gives the total membership as 515, which includes 293 fellows and 135 associates. There is stated to be unlimited scope for further applications of physics in the arts, industries, and public services, and therefore for the increased employment of highly-qualified physicists, and during the past year there has been a fair demand for young honours graduates in physics with two or three years' research experience. Seven lectures have so far been given in the series on "Physics in Industry," and they have been published in three volumes by the Oxford University Press. Much of the report is devoted to the *Journal of Scientific Instruments*, the second volume of which is now appearing. Editorial control has been brought into closer touch with the scientific instrument industry, and steps have been taken to procure more descriptions of workshop devices and methods. Action has been taken in conjunction with the Institute of Chemistry in urging upon the Board of Trade the desirability of defining, in the public interest, the qualifications that should be required of Gas Examiners appointed by local authorities under the provisions of the Gas Regulation Act, 1920. In this connexion a deputation from the two Institutes waited upon the Board of Trade. In reply to the deputation it was stated that the changes in the method of appointment of Gas Examiners suggested by the deputation indicated the necessity for further statutory powers.

THE Ladies' Conversazione of the Royal Society will be held in the Society's rooms on the evening of Wednesday, July 22.

THE summer meeting of the Newcomen Society for the Study of the History of Engineering and

Technology is to be held on June 17-20 at Gloucester. The meeting includes visits to works and places of antiquarian interest in the neighbourhood. Particulars can be obtained from the honorary secretary of the Society, Mr H. W. Dickenson, Science Museum, South Kensington, London, S.W.7.

THE Science Museum at South Kensington, being too crowded on public holidays for the ordinary lectures to be given in the galleries, an experiment was made on Whit-Monday by Engineer-Capt. E. C. Smith, the official guide lecturer, giving short lectures on ships, locomotives, and aeroplanes in one of the new demonstration rooms. The lectures were illustrated by slides, models, and sketches, and drew large audiences. The experiment may be regarded as entirely successful, and we hope these holiday lectures will become a permanent feature of the work of the Museum.

WE learn from *Science* that the Barnard Medal for Meritorious Service to Science, awarded by the trustees of Columbia University on the nomination of the National Academy of Sciences, has been given to Dr. Niels Bohr, professor of physics at the University of Copenhagen, in recognition of his researches on the structure of atoms. Previous recipients of the Barnard Medal are: Lord Rayleigh and Sir William Ramsay (1895); Prof. W. K. von Röntgen (1900); Prof. Henri Becquerel (1905); Sir Ernest Rutherford (1910); Sir William Bragg and Prof. W. L. Bragg (1915); Prof. Albert Einstein (1920).

It is a hundred years since John Phillips, afterwards professor of geology in King's College, London, in the University of Dublin, and in the University of Oxford, was appointed the first keeper of the Museum of the Yorkshire Philosophical Society. In the recently issued annual report of the council of that Society, Dr. W. E. Collinge, the latest successor of Phillips, takes occasion to give an interesting account, illustrated by a good portrait, of the great geologist of Yorkshire. He suggests that a John Phillips Geological Department would form a fitting memorial. The council, however, seems to be concentrating on an extension of the Museum to accommodate the Roman antiquities.

AFTER the death of Dr Peringuey in February 1924, and pending the appointment of the new director, Mr. E. Leonard Gill, who assumed office on January 1 of this year, the work of the South African Museum was under the supervision of Mr. K. H. Barnard, who is responsible for last year's report. The much-needed whale shed was completed during the year, and the whale skeletons re-erected therein, proving a great attraction to the public. Several short talks on matters connected with the Museum have been broadcast. The excellent custom of employing members of the staff on collecting expeditions and surveys was continued, though somewhat interfered with by the administrative changes. The chief acquisitions by this means were in plants, insects, and arachnids.

AN interesting paper on the early Bristol glass-houses appears in the March issue of the *Journal of the Society of Glass Technology*. It contains historical details of the fortunes of many glass-making firms, and is based mainly on contemporary newspaper accounts. The earliest record of glass-making in Bristol occurs about 1651, when Edward Dagney (or Dagna), an Italian, had a glasshouse, of which the master was John Williams. The trade rapidly grew; in 1698 there were six glasshouses for bottles and four for flint glass; in 1761 there were fifteen, and in 1792 "about twelve" (probably concerns or firms). The Bristol industry began to decline during the early part of the nineteenth century, owing to the remoteness of coalfields and Irish competition.

THE most recent Catalogue (No. 68) of Messrs. Watson and Sons (Electro-Medical), Ltd., consists of Part I., dealing with X-ray generators and radium, and Part II. with X-ray accessories. In about three hundred pages a brief descriptive account is given of radiological apparatus covering the field of radio-diagnosis and radio-therapy. We notice a description of the Gaiffe-Gallot and Pilon constant tension apparatus which Messrs. Watson are authorised to manufacture in Great Britain. One of the most attractive features of the catalogue is the conciseness of descriptive details concerning apparatus, combined with excellent illustrations.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: A veterinary lecturer at the Midland Agricultural and Dairy College, Sutton Bonington, Loughborough—The Principal. An assistant lecturer in chemistry at King's College for Women (Household and Social Science Department), Campden Hill Road, W.8—The Secretary (June 12). A junior scientific assistant in connexion with Admiralty Research—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (June 16). Some appointments in connexion with the physical and chemical survey of the national coal resources—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (June 17). The professorship of zoology at King's College, London—The Academic Registrar, University of London, South Kensington, S.W.7 (June 19). An assistant entomologist at the Imperial Forestry Institute, Oxford—The Secretary (June 20). A junior lecturer in biological chemistry in the department of physiology of Bedford College for Women—The Secretary (June 20). An assistant in the Herbarium, Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (June 22). The professorship of electrotechnics in the University of the Witwatersrand—The Secretary, High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (June 25). A senior lecturer in chemistry and physics at the Gordon College and the Kitchener School of Medicine, Khartoum—Dr. A. F. Joseph, 51 Kings Avenue, Muswell Hill, N. (July 14). A biology demonstrator at the Royal Grammar School, Worcester—The Headmaster.

## Research Items.

ARCHÆOLOGICAL EXPLORATION IN INDO-CHINA.—Dr. R. Verneau describes in *L'Anthropologie*, T. 35, Nos 1-2, the results of excavations in the caves of Bac-Son, Tonkin, by Dr Mansuy and Mlle. Colani of the Geological Service. Some years ago Dr. Mansuy demonstrated by excavations at Pho-Binh-Gia that the neolithic culture characteristic of Indo-China—the only type known until then—was preceded by a more archaic culture. Three skulls associated with this early phase were found to differ entirely from the modern population. Further investigations, covering a large number of caves, have revealed a stone culture, apparently general over the area of excavation, of which the implements are of early palæolithic type—Acheulean. No fossil remains are present, and the animal bones found in the archæological deposits are all those of existing species. This, coupled with the absence of any of the stages intermediate between the implements of Acheulean type and the polished neolithic implements of the later culture, points to an antiquity of no great degree such as might be inferred from the form alone of the early implements. It is suggested that a primitive culture lingered on until overwhelmed by the incursion of races acquainted with the art of polishing stone. Two skeletons were found; one skull was sufficiently well preserved to admit of measurement; but whereas the skulls from the earlier excavation mentioned above were of a pure Indonesian type, this one is Melanesian; while another skull recently found in the cave of Minh-Cam in Annam presents the characteristics of a Negrito.

EARLY ART IN THE EUPHRATES VALLEY.—The light thrown upon Sumerian Art and its affinities by the discoveries at Tel el Obeid is discussed by Dr. Leon Legrain in the *Museum Journal* (Philadelphia), vol. 15, No. 3. A foundation tablet of Ur-Engur suggests the identification of El Obeid with the city of Kesh and a connexion with Elam, from which tamed bulls and cows probably were first brought to Sumer. The details of the dairy scene in the copper relief from the oldest temple at El Obeid help to explain archaic pastoral scenes from Susa, Tello, and Nippur. A text of Gudea of Lagash dealing with the organisation of the household of the god Ningirsk, refers to a dairy. It also in its ritual details suggests the old mythology of Elam. But while the Elamite was a hunter the Sumerians were farmers. The Elamites represented the gods as composite monsters; the Sumerians adopted the same forms, but in Sumer the god soon assumes the appearance of a king seated on his throne, the ancestor animal surviving as his servant and emblem. A number of known monuments may be compared with the art of Tel el Obeid. These, taken together, seem to bridge over the gap between the pre-Sargonic and pre-Elamite periods. Similar objects have been found by the French at Susa, Tape Mussian, and Bandar Bushir. The pre-Elamite period, represented by the painted wares and engraved seals, seems to be the oldest. The Tel el Obeid art is not so primitive but is to be set apart from, and before the pre-Sargonic period, constituting a new period of art.

THE BIOLOGY OF WHITE MUSTARD.—This subject in the hands of F. Boas and F. Merckenschlager has given results of great scientific interest and of considerable practical bearing. Their results are published in the *Biol. Centralblatt*, 45, pp. 40-53, 1925. That white mustard had some peculiarities had long

been known; thus since 1913 the great difficulty of growing the plant in water culture has been on record, and there are also reports as to its failure to develop in soils previously sterilised by heat. In both these cases, growth could be improved by adding strongly adsorbing substances to the culture medium. Attacking the problem from this angle, these authors now supply very good experimental evidence that these peculiarities are due in the main to the ready penetrability of the plant's tissue by anions. If, for example, roots of mustard seedlings are placed in a 0.5 per cent. solution of ferrous sulphate, within 15-20 minutes the roots are covered with yellow-brown flecks of the hydroxide of iron, other plant roots remaining clear white for hours in such a solution. The root systems of old flowering plants do not show this peculiarity to such a marked extent, but leaf-stalks and hairs show this same ready penetrability to anions. As *Sinapis arvensis*, charlock, has the same peculiarities as *S. alba*, though perhaps to a less degree, this seems to be the phenomenon underlying the practice of destroying charlock by spraying or dusting.

MAIZE IN SOUTH AFRICA.—The increasing importance of the maize crop in South Africa has led to an inquiry into the economics of its production in connexion with the capital required in maize farming, the equipment and labour necessary, the yields and returns obtained, the relation of yield to cost and other points of importance to maize growers. Incidentally, weak points in the system of farming have been exposed, providing valuable information to the farmers. The report on the Cost of Production of Maize Investigation for 1921-22 (by E. Parish, Orange Free State) sets out the means employed in obtaining information and the method of calculation adopted. Costs for native labour, ox labour, and overhead charges were estimated on a comprehensive basis including such incidentals as perquisites, veterinary attendance, and the cost of stalk grazing and husks consumed. The range of costs per bag, including transport, on the thirty-nine farms investigated in a poor season was from 4s. to 11.14s. 11d., the greatest number of results lying between 7s. and 9s., but in a normal season the costs would be lower. The crop yields showed a similarly wide range, from 0.43 to 80 bags per acre (1 bag = 203 lb.), and comparison shows that the relation between yield and cost is very close. Compared with similar figures for several states in U.S.A. the cost of manual labour in South Africa is greater per acre of maize, but land is relatively cheaper and ox labour is less expensive than horse labour. The cost per bag of maize may be brought down by adequate methods of farming, and suggestions are made for obtaining increased yields.

EARTH MOVEMENTS IN CALIFORNIA.—A most comprehensive scheme of research is now being carried out in California with the object of investigating from every possible point of view the alarming disturbances to which the earth's crust is subject in that region. A valuable summary of progress is outlined by Dr. A. L. Day in *Science*, vol. 61, March 27. The U.S. Coast Survey and the Hydrographic Office have triangulated the land and contoured the adjoining ocean floor, and have thus provided a trustworthy system of co-ordinates upon which future displacements can be accurately plotted. The Geological Survey and the universities in California are studying

the geology in adequate detail. The California Institute of Technology, the Mount Wilson Laboratory, and the Geophysical Laboratory of Washington have devised apparatus and established stations for the more systematic recording and study of local earthquakes. It is not surprising that great faults are found along the Californian coast, for the Sierra Nevada rise to more than 14,000 feet on the east, while to the west the ocean floor drops sharply to a depth of 12,000 feet. High temperature gradients and hot springs and unusually great anomalies of gravity, show further that the region is one of exceptional instability. The danger zones of structural weakness are being carefully mapped, and in future the known directions and magnitudes of the creeping and tilting movements that occur along them as the stresses accumulate will lead to definite predictions of the place or places where earthquakes are likely to occur. Unfortunately, there is no certainty that prediction of the time of rupture is yet a problem that can be usefully attacked.

**ABYSSAL SUBMARINE VOLCANOES.**—The soundings made by the *Challenger* expedition have been investigated by M. J. Thoulet, *C.R. Acad. d. Sci., Paris*, March 16. In the oceanic depths he has found that, in some cases, the curves of submarine density, instead of continuing regularly to the bottom, begin to show a sudden increase in density, the amount of material in solution becoming suddenly greater than before. This appears to be due to the existence of basins, without outlet horizontally, containing submarine volcanoes, which give out materials which dissolve in the water. This increase of density at the bottom of the ocean is not general. In regions in the North Atlantic known to be volcanic, the proportion of bottom densities greater than 1.0280 is 84 per cent.; in the South Pacific it is 37 per cent.; in the South Atlantic, 24 per cent.; in Indian Ocean, 13 per cent.; and North Pacific, 2 per cent. M. Thoulet has specially studied certain regions, partly from the point of view of submarine topography and microlithology, and partly with regard to the density of the water. He expresses the view that it may be possible in this way to locate the position of abyssal volcanoes, and perhaps to evaluate the degree of their activity.

**SUBSTITUTES FOR PETROLEUM.**—In his presidential address to the Mining and Geological Institute of India (published in the *Transactions*, vol. 19, 1924), Dr. E. H. Pascoe dealt with the development of the oil industry, and paid considerable attention to the question of vegetable and other products as substitutes for petroleum. Practical experiments have been made with palm oil in the Belgian Congo, where, under tropical conditions, it has been found possible to run a two-cycle semi-Diesel motor on this fuel, resulting in the development of 10 h.p. at 500 revolutions per minute. The calorific value of palm oil is, however, 20-25 per cent. less than that of crude petroleum, so that even if it could be used satisfactorily under temperate conditions, the greater consumption unit for unit would have to be balanced by low cost to make it an economic proposition. Castor oil has already been successfully used as a fuel for internal-combustion engines, though, as with pea-nut, soya-bean, and coconut oils, its value for human consumption is great, and any application as fuel would involve the oil industry in serious competition with the food-stuffs and drugs industries. Tetralin is a tetra-hydro-naphthalene manufactured from coal-tar in Germany; this substance was used satisfactorily during the War in that country, when supplies of petrol were short, but it suffers from the same disadvantages as benzol, namely, rapid carbonisation

and difficulty in starting the engine on it from the cold. The prospect of an extended use of tetralin is doubtful. Alcohol is probably the most promising of all the liquid substitutes for oil, chiefly because of the variety of raw materials from which it can be manufactured, e.g. molasses (sugar waste), maize, potatoes, sawdust, sulphite liquors (from paper manufacture), artichokes, sorghum, various wild fruits and berries, peat, corn-stalks, garbage and other waste products. Dr Pascoe concluded his address by urging attention to efficient carbonisation of coal, not only as helping to solve future fuel problems, but also owing to a growing demand for metallurgical coke. The problem of the conversion of cellulose into fermentable material by simple and economic chemical or bacteriological processes is likewise one worthy of thorough investigation, and in commending this and other researches having a similar end in view to Indians for the benefit of posterity as much as their own country, he voiced a plea deserving of world-wide notice and support.

**THE INITIAL VELOCITIES OF  $\alpha$  RAYS FROM POLONIUM.**—The  $\alpha$  rays emitted by the same radio-active body have been found to have very nearly the same velocity; Geiger, using radium C, finds this to be true to within 0.5 per cent. Mlle. I. Curie, using polonium, found that the ranges of its  $\alpha$  rays differed a little more than was to be expected by the theory; and in a paper in the *C.R. Acad. d. Sci., Paris*, March 16, she describes measurements made by the magnetic deviation method, to find the amount of difference in the velocity of these rays on emission. The rays were passed through two parallel slits before being deviated, and the width of the line formed on the photographic plate depended in part upon the relation between the velocity of the different rays emitted. Other factors affecting this width were investigated, various possible distributions of velocity were considered, and it is shown that it is necessary to measure the ratio between the intensity at the middle of the line and that at its edges. The final result is that there is no indication of any difference in the initial velocities; if it is assumed that the velocities are distributed uniformly between two limits, the extreme difference cannot be more than 0.3 per cent. If, on the other hand, the velocities are assumed to be distributed about the velocity  $V$  according to the probability law, 75 per cent. of the rays have velocities which differ by less than 0.3 per cent.

**THE THERMAL EXPANSION OF HALIDES OF THE ALKALI METALS AT VERY LOW TEMPERATURES.**—A series of measurements, carried out in collaboration with Frl. H. Krüger and Messrs. H. Wiens and J. Hähnel, is described by Frl. A. Henglein in the *Zeitschrift für physikalische Chemie* of February 25. The densities of sodium and potassium chlorides, bromides, and iodides were determined by the pyknometer method at 0° C and -79° C., and it was found that salts prepared by fusion have a higher density than those crystallised from aqueous solution. The density was also determined with a gas volumometer at room temperature, 0° C., -70° C., and -184° C., the accuracy attained being about  $\pm 0.5$  per cent., using about one gram of salt. The densities are tabulated, those of sodium chloride together with the values of  $\nu$ , the distance between the centres of unlike ions of this substance and the mole volumes being given in the following table:

Temp.	Density.	$\nu \times 10^8$ cm.	Mole Volume.
0	2.168	2.813	26.97
-79°	2.186	2.805	26.74
-184°	2.208	2.796	26.48
-273°	...	2.793	26.41

Grüneisen's law (atomic heat/coefficient of expansion is a constant for all temperatures) holds, so that it is possible to calculate the molecular volume at absolute zero, and so find  $\nu$  at that temperature. The percentage alteration of the molecular volume from 0° to absolute zero is for sodium chloride, 2.1; potassium chloride, 2.1; potassium bromide, 2.3 per cent., or nearly the same number. When the cation remains the same, the coefficient of expansion increases with increased atomic weight of the anion; when the anion is the same, the coefficient diminishes with increased atomic weight of cation.

**ALTERNATING CURRENTS AND OVER-VOLTAGE PHENOMENA.**—S. Glasstone, in the April issue of the *Journal of the American Chemical Society*, records some observations on the effect of small alternating currents on cathodic and anodic over-voltage for a series of metals in normal acid and alkali. The results indicate that only in a limited number of cases does alternating current of small amplitude reduce the polarisation at such electrodes. A possible explanation of this reduction is discussed.

**ATOMIC SPACING IN ORGANIC COMPOUNDS.**—The results of X-ray investigations on saturated aliphatic ketones and hydrocarbons are recorded in the March number of the *Journal of the Chemical Society*. The work, which was carried out by W. B. Saville and G. Shearer in the case of the ketones and by A. Müller and W. B. Saville in the case of the hydrocarbons, shows that a study of the X-ray spacing gives an indication of the number of carbon atoms in ketones, and a consideration of the intensity distribution enables the position of the carbonyl group to be located within fairly narrow limits. All the (normal) hydrocarbons which were examined exhibited two typical sets of spacings, one, relatively large, increasing linearly with the number of carbon atoms in the molecule, and the other very nearly independent of this number. The increase per carbon atom of the long spacing is too large to be accounted for by the longest of the tetrahedral chains; some additional variable must be introduced to explain the behaviour. Octadecane,  $C_{18}H_{38}$ , and eicosane,  $C_{20}H_{42}$ , appear to exist in two crystalline modifications.

**VISCOSITY AND ALLOTROPY OF GLASS.**—The March issue of the *Journal of the Society of Glass Technology* contains a paper on the viscosity and allotropy of glass, by H. le Chatelier. M. le Chatelier gives a theoretical discussion of the work of Washburn and Shelton and of English, and finds that the results of these workers may be expressed by the relation  $\log(\log \eta) = M(t - 1000)/1000 + N$ , where  $\eta$  is the viscosity,  $M$  the rate of variation of  $\eta$  as a function of temperature  $t$ , and  $N$  is the viscosity at 1000°, *i.e.* in the middle of the working zone of glass. The greater  $N$  is, the harder is the glass; the smaller the value of  $M$ , the more extensive is the range of fusibility of the glass. No definite relation has been found between the chemical composition of glass and its range of fusibility, but a connexion definitely exists between composition and viscosity. Glass exhibits an allotropy phenomenon similar to sulphur, with the difference, however, that in the case of glass changing its state, only the law of variation of viscosity as a function of temperature is altered, not the absolute value. There is some uncertainty as to the temperature at which the transformation takes place.

**COBALT.**—An account of the production and uses of cobalt, by T. H. Gant, appears in *Chemistry and Industry* for February 13 and 20. The chief sources

of supply are Canada and Australia, the main ores being smaltite, cobaltite, and asbolite. The latter is a mixture of metallic oxides and may contain up to 30 per cent. cobalt oxide. In Canada, the ores are worked for the small quantities of precious metals which they contain, the cobalt being recovered as a by-product. The ore is smelted with a flux (*e.g.* lime if the ore is siliceous), a certain amount of iron being allowed to enter the speiss, or crude arsenide, which is formed. Its presence prevents the passage of cobalt into the slag in any appreciable quantity. The slag is re-smelted; the speiss is then calcined, the arsenic driven off being collected and sold. The roasted speiss, which contains about 10 per cent. of arsenic, is treated with hot hydrochloric acid and allowed to settle. The filtered mother liquor is nearly neutralised with lime, when nickel hydroxide and ferric arsenate are precipitated, enough iron having been added to convert all the arsenic to this compound in the acid treatment stage. The remaining arsenic and copper are removed by sulphuretted hydrogen, or, in the latter case, electrolytically. The solution now contains only cobalt and nickel chlorides; the former is precipitated by adding just the correct quantity of lime and the nickel solution, after separation, is precipitated by adding further quantities of lime. This method of separation of these metals has a very interesting history. The metal is obtained from the oxide by mixing the latter with a starchy material and heating to a high temperature in a retort. The principal and oldest use of cobalt oxides is in the ceramic industry; they are used as stains, either body stains, glaze stains, or under-glaze stains. Certain salts (*e.g.* hydroxide, borate, oleate) are finding use as driers; certain organic salts of cobalt are the most efficacious and convenient driers known. Cobalt, in the form of smalt, is also used for colouring enamels blue, and the oxide is used to neutralise any yellow colour in a white enamel caused by iron oxide. Electroplating with cobalt solutions seems to be more satisfactory than with nickel, the plating occurs much more rapidly and a lesser weight of hard cobalt deposit offers the same protective coat as a greater weight of the softer metal.

**INDUSTRIAL ILLUMINATION.**—Within recent years much attention has been directed to the rapidity with which operations involving vision can be accomplished under various intensities of illumination. The General Electric Co. of America has published in the *Journal of the Franklin Institute* for April a paper on this subject by P. W. Cobb, who is a psychologist, and F. K. Moss, who is a physicist. A large number of experiments were carried out and definite curves connecting brightness with mechanical precision were obtained. Extreme values of brightness were not used, so the problem is not complicated by the introduction of glare. The results of this investigation prove that for accurate mechanical work the brightness must exceed a definite value. They can consequently be applied directly to many industrial operations. When the output is on a quantity production basis and the various operations follow one another at fixed and predetermined intervals, the gain in accuracy shown by the laboratory experiments in increasing the brightness to the definite value would be realised in practice. It has been objected that the better illumination induces the workers to function their eyes at an unnatural rate and so they would be more fatigued at the end of the day. The evidence, however, does not support this objection. Eye fatigue is not generally experienced in daylight, where the illumination is generally several hundred times that of present artificial lighting.

## The Fat Soluble Vitamins and Irradiation in Nutrition.

OUR knowledge of the properties and effects of those elusive accessory food factors, usually designated by the term "vitamins," is gradually being extended by the labours of a large number of research workers: a short account of some of the more recent work on the fat soluble vitamins may prove useful, both from its intrinsic scientific interest and also from the influence it may have on the practical problems of human and animal dietetics. No discussion of this subject nowadays would be complete without mention of the effect of irradiation with ultra-violet rays as a substitute for, or a generator of, the fat soluble vitamins, or of the influence of these factors in the prevention and cure of rickets.

The animal organism is dependent for its supply of fat soluble vitamin-A upon the vegetable world: two most important sources are the fresh green leaves of many plants and the liver of fishes, where the vitamin obtained from the food is concentrated in association with the fat (cod liver oil). Now its presence in green leaves and the effects of irradiation to be considered later have suggested that its synthesis may be effected only or chiefly in the presence of light, but Ethel M. Luce and Ida S. Maclean (*Biochemical Journ.*, 1925, vol. 19, p. 47) have concluded that it can be formed by yeast cells in the absence of sunlight: it can easily be extracted from the dried yeast by ether.

Vitamin-A is characterised by being associated with the fats of both plant and animal tissues, but it frequently happens in modern life that it is precisely these two types of foodstuffs which fail to reach the consumer in a fresh or natural condition. Appropriate sources of the vitamin for human consumption are green leaves, milk and butter, and cod liver oil: but the leaves are frequently cooked, the milk may contain little of the vitamin to start with, and still less after the treatment it may undergo before consumption, margarine may replace butter in the diet, whilst raw cod liver oil is unpalatable without further treatment. What factors may destroy the vitamin and how may this destruction be avoided? How may an adequate supply be ensured in the human diet?

It is known that the fat soluble factor is easily oxidised, especially at a high temperature: but in an atmosphere free from oxygen it will withstand a temperature of more than 100° C. without much loss of its activity. S. S. Zilva (*ibid.*, 1924, vol. 18, p. 881) has shown that the hardening of cod liver oil in the absence of oxygen does not result in the destruction of the vitamin: this fact may have an important bearing on the preservation of the factor in margarine, which is largely made from hardened oils. Most often, however, the vegetable oils used contain little or none of the vitamin before the hardening process takes place. Storage alone, for example of cod liver oil, does not result in complete destruction although the activity of the oil gradually becomes less: the presence of the vitamin in a sample thirty years old has been detected by E. Poulsson (*ibid.*, 1924, vol. 18, p. 919).

Since animals do not form vitamin-A, it is important to see that animal products used as food should come from animals which have had an abundant supply of the vitamin in their diet. The most important products in this connexion are undoubtedly milk and its derivatives. Ethel M. Luce (*ibid.*, 1924, vol. 18, p. 1279) has compared the effects of sunlight and a diet rich in vitamin-A in producing a milk rich in this factor. At this point we must digress for a moment to mention that the methods of testing for

the presence of the vitamin by feeding animals on a diet deficient in the factor supplemented by the product under test have led to the conclusion that there is probably more than one fat soluble vitamin in existence: one is concerned with the *growth* of animals whilst the other keeps this growth in normal channels, the former may be called the *growth* factor (or vitamin-A) and the latter the antirachitic factor. Luce has found that cow's milk only contains the growth factor when it is present in the food of the cow, but that exposure of the animal to sunlight whilst on a diet deficient in vitamin-A increases somewhat the content of the antirachitic factor in the milk; the amount of this latter factor is, however, increased much more by the presence of fat soluble vitamins in the cow's diet. The quantity and fat content of the milk are not apparently increased by a diet rich in vitamin-A, from some experiments on goats by E. T. Sheehy (*Proc. Roy. Dublin Soc.*, 1924, vol. 17, p. 333).

The study of experimental rickets has shown the importance of the fat soluble vitamins in the etiology of this disease, but it is probable that other factors are concerned as well. The question is complicated by the fact that rickets is a disease of growth and may not be developed if the animals are on a diet from which fat soluble vitamin-A has been excluded, the animals on this diet ceasing to grow. If the diet is simply deficient in the vitamin, so that growth does occur, then rickets will also appear. S. S. Zilva, J. Golding, and J. C. Drummond have recently shown this to be true also in the case of young pigs (*Biochem. Journ.*, 1924, vol. 18, p. 872). On the other hand, if young animals are fed on a diet which, besides being deficient in fat soluble vitamins, is badly balanced as regards the proportion of its mineral elements, or deficient in calcium or phosphorus, rickets can be produced fairly easily, although growth may be also retarded. This conclusion shows that it is essential to consider not only the vitamins but also the other elements of the diet, especially the minerals, in connexion with this disease.

Attention must be directed to a further factor which influences the development of rickets. The animal body seems able to store a supply of the fat soluble vitamins, so that until this store has been exhausted, exposure to a deficient diet will be without effect. The amount in this store will obviously depend on the diet given before the experimental period commenced, and it has been found that the diet of the mother during pregnancy and lactation has a marked influence in this respect, a conclusion which has an obvious practical bearing on human dietetics. Thus V. Korenchevsky and Marjorie Carr (*Biochem. Journ.*, 1924, vol. 18, pp. 1308, 1313, and 1925, vol. 19, p. 112) have shown that if the mother's diet is deficient in fat soluble vitamins during pregnancy and lactation, the young (rats) placed on a deficient diet at weaning develop rickets more easily than those whose mothers had been fed on a rich diet during corresponding periods. An excess of calcium in the mother's diet, provided that the fat soluble vitamins are in excess also, still further improves the resistance of the young to the development of rickets afterwards. If the parent rats of either sex are fed on a deficient diet before mating, the animals are less fertile, and the young born are weaker than normal, but there is no sign of any deficiency of calcium in their skeletons; thus the mother draws on her own reserves for the sake of her young.

Once rickets has developed on a deficient diet, it has been of interest to determine whether any

other factors besides the replacement of the missing vitamins will have any influence on the course of the disease. The addition of more calcium or phosphorus to the diet has little effect, unless these elements are already deficient; but V. Korenchevsky and M. Carr (*ibid.*, 1925, vol. 19, p. 101) have found that the subcutaneous injection of calcium glycerophosphate may improve the calcification of the animals on the deficient diet; the injection of sodium phosphate alone was almost without effect. Apparently only a certain maximum amount of calcium can be absorbed from the digestive tract; but that this is probably not due to the absence of the vitamins from the diet is shown by the results of some experiments by Katharine M. Soames (*ibid.*, 1924, vol. 18, p. 1349); the intraperitoneal injection of cod liver oil in rats afforded some protection against rickets; presumably these vitamins exert their influence on the tissues after absorption and do not facilitate the absorption of other elements of the diet. The same author in collaboration with R. Robison (*ibid.*, 1925, vol. 19, p. 153) has investigated further the cause of the deficient calcification of the bones in rickets. They find no deficiency in the blood of the phosphoric ester hydrolysable by the bone enzyme or of the enzyme itself in the bones. The administration of cod liver oil has no effect on this ester or on the enzyme, but increases the organic phosphorus present in the blood. It only influences the inorganic phosphorus of the blood when the diet is deficient in this element. The inference from their results is that the deficient calcification on a diet deficient in the fat soluble factor alone is due to a deficiency of calcium ions; deficiency of phosphorus only plays a part when the diet is deficient in this factor also.

A further factor in the cure or prevention of the effects produced by a diet deficient in fat soluble vitamins has been found within the last few years in the influence of ultra-violet rays. In the earlier observations children suffering from rickets were

exposed directly to the source of light, with the result that the bone lesions were healed; the subject was taken up experimentally later and it was found that the growth of rats could also be stimulated by ultra-violet light when the animals were fed on a diet deficient in fat soluble vitamins. Later work has suggested that the ultra-violet rays may cause a synthesis of the antirachitic factor, but only a mobilisation of the body's store of vitamin-A without a true synthesis. This agrees with the results of Luce and Maclean mentioned above, who conclude that light plays no part in the formation of vitamin-A. Some of the other effects of irradiation have recently been referred to in these pages (December 20, 1924, p. 901, and May 2, 1925, p. 642).

A further step from this work was the examination of the effects of the ultra-violet rays upon the food given to the animal; and S. J. Cowell (*Brit. Med. Jour.*, 1925, vol. 1, p. 594) has tried the effect of feeding irradiated milk to rickety children; his paper also gives a brief account of some of the earlier work on irradiation. He has found that the irradiated milk has produced a great increase in the calcification of the bones of two children with rickets, whilst a third fed on the same milk without irradiation showed very much less improvement. It appears then that the antirachitic factor can be synthesised outside the body under the influence of ultra-violet light; this conclusion is of great importance, since it implies that a further method is available for the improvement of a ration which we may suspect to be deficient; it also opens up the way to a knowledge of the chemical constitution of the antirachitic factor and possibly its supply in some convenient and more palatable form than cod liver oil.

Further information as to the use and effects of light treatment in disease, together with accounts of the physiological actions of ultra-violet radiations, may be found in articles by J. H. Sequeira and W. J. O'Donovan (*Lancet*, 1925, vol. 1, p. 909) and F. H. Humphris (*ibid.* p. 912).

### Power Alcohol from Root Crops.

THE third memorandum of the Fuel Research Board on fuel for motor transport<sup>1</sup> deals with the production of power alcohol from tuber and root crops in Great Britain. Potatoes, mangolds, and Jerusalem artichokes are the only practicable raw materials which could be grown for this purpose, but it seems unlikely that potatoes would prove of economic value in this respect. One ton of potatoes produces 20 gallons of 95 per cent. alcohol, so that every pound sterling it costs to grow a ton of potatoes is equivalent to 1s. on a gallon of alcohol for raw material alone. Co-operation between the potato grower and distiller has been suggested as a means of utilising the distillery residues for cattle-feeding, and so reducing the net cost of the power alcohol. In the southern counties the mangold is superior to the potato in that it is easier to grow, harvest, and store, and is less liable to disease and failure, while the manufacture of alcohol from it is simpler as the carbohydrates are in the form of sugar. The comparative cost per gallon for the raw material works out at 7s. for potatoes and 3s. 9d. for mangolds. The latter cannot, however, be grown in the north of England and Scotland owing to its susceptibility

to frost. The distillation residues would appear to have considerable value as an ingredient in a feeding material rich in carbohydrates but poor in protein.

The Jerusalem artichoke will grow in almost any well-drained soil, and as it is difficult to clear the ground completely when harvesting, no replanting is needed for many years when once a plot is well established, the cultivation being thus reduced to a minimum. The crop yields are very variable, probably being about 10-12 tons per acre in England, and 15-25 gallons of 95 per cent. alcohol per ton of tubers have been produced. Experiments also indicate that by using an organism of the *Bacillus butylicus* group, about 12 gallons of mixed butyl alcohol and acetone can be obtained. The simultaneous fermentation of the tubers by yeast and the same organisms yielded a liquor consisting of 70 per cent. of ethyl alcohol, 10 per cent. of acetone, and 20 per cent. of butyl alcohol. The sun-dried artichoke stalks can be so treated as to give a pure resistant cellulose at the rate of about  $\frac{1}{4}$  ton per acre, of a type that would be very suitable for certain purposes.

The memorandum concludes with a series of tables setting forth the results of cultivation experiments together with various analytical figures.

<sup>1</sup> Department of Scientific and Industrial Research: Fuel Research Board. Fuel for Motor Transport: Third Memorandum. Power Alcohol from Tuber and Root Crops in Great Britain. Pp. vi+37. (London: H.M. Stationery Office, 1925.) 9d. net.

### Ascent of Beerenberg, Jan Mayen.

THE island of Jan Mayen in the Greenland Sea has been known at least since the early seventeenth century, when it was much frequented by whalers, and was the site of the Austrian meteorological station of 1882-83. The Austrians made an unsuccessful attempt to reach the summit of the volcanic peak of Beerenberg, being foiled by bad weather. In the summer of 1921, the Norwegian meteorological service sent an expedition to Jan Mayen to erect a wireless station. This afforded a passage to Dr. P. L. Mercanton, who was anxious to climb Beerenberg. He was joined by Mr. J. M. Wordie, Mr. T. C. Lethbridge, and three other Cambridge men. In *Écho des Alpes*, No. 8 (Lausanne), 1924, Dr. Mercanton gives an account of the successful climb.

The mountain arises at the north-east end of the small island, and although records occur of volcanic activity on the island in 1732 and 1818, there is no evidence that the main crater has been active during historic times. Certainly there is no sign of recent lava flow. The party ascended the mountain from the south-west by Ekerold Valley over barren ground strewn with volcanic tombs, and passing to the west of Esk or Vogt crater, reached the frontal moraines of the summit glacier at about 2770 feet. The route was then over a gentle ice slope without crevasses to a prominent nunatak at 5249 feet. This was marked by a cairn probably erected by the Austrians as a survey mark. Higher up, a crevassed surface was encountered, but the only real difficulty seems to have been when the bergschrund was reached. At 7448 feet the rim of the ice-filled crater was reached. This crater is about half a mile across, and from a gap on its northern side the Weyprecht glacier falls to the coast.

Beerenberg has two peaks, of which the higher is on the western side of the gap. This was reached along a snow *arête*. Dr. Mercanton gives the summit height as recorded by aneroid as 7661 feet (2335 metres). The figure obtained by the Austrians by theodolite measurement was 8350 feet (2545 metres). This may be compared with Mr. Wordie's figure of 8090 feet, which was also obtained by aneroid reading. The discrepancies between these figures are considerable, but the Austrian figures are not without doubt, largely because they worked with a very small angle. The paper is illustrated by a number of excellent photographs of the mountain and a reproduction of the Austrian map.

### University and Educational Intelligence.

BRISTOL.—Their Majesties the King and Queen will open the new wing of the University on June 9. The new buildings are the gift of Sir George Wills and the late Mr. H. H. Wills, in memory of their father, and consist of an imposing tower and a building housing the administrative departments of the University, the main library of the Faculty of Arts and the medical works presented by the Bristol Medical and Chirurgical Society, as well as a number of lecture rooms. The provision of new accommodation for the Faculty of Arts releases a number of rooms adjoining the geological and biological departments, which will thus be afforded much-needed space for expansion.

CAMBRIDGE.—A grant of 25*l.* has been made from the Balfour Fund to Mr. J. T. Saunders, Christ's College, for an investigation of the diurnal movements of the zooplankton of the Swiss lakes. Dr. H. S. Pruthi, Peterhouse, has been nominated to use the University Table at the Zoological Station at Naples for one month.

Mr. D. Keilin, Magdalene College, has been appointed University lecturer in parasitology. Mr. J. A. Carroll, Sidney Sussex College, Assistant Director of the Solar Physics Observatory, has been appointed University lecturer in astrophysics.

The following grants have been made from the Worts Fund:—100*l.* to G. E. Barton, Gonville and Caius College, towards the expenses involved in a visit to Sumatra and elsewhere to complete a study of limestone denudations and other subjects; 100*l.* to A. B. Deacon, Trinity College, towards the expenses involved in a visit to the New Hebrides for ethnological study; 40*l.* to W. G. East, Peterhouse, for a visit to Vienna to inspect certain Foreign Office documents in connexion with historical research; 30*l.* to J. Needham, Gonville and Caius College, for researches on the oxidation-reduction potential of the cell-interior to be carried out at Roscoff in Brittany.

LONDON.—The three following courses of free public lectures have been arranged: "The Biological Aspect of Hydrographical Work," by Dr. J. Schmidt, at University College, at 5.30 o'clock, on June 8 and 9; "Blood and Circulation from the standpoint of Physical Chemistry," by Prof. L. J. Henderson, at University College, at 5.30 o'clock, on June 10, 11, and 12; and "Cardiology," by Prof. J. Hay, at University College Hospital Medical School, at 5 o'clock on June 11, 12, 18, and 19.

OXFORD.—An election to a fellowship in physiology at New College will take place in October. Particulars and the necessary form of application may be had from the Warden, to whom the completed form must be returned not later than June 15.

ST. ANDREWS.—The University Court has appointed Mr. David Jack, at present associate professor in the Carnegie Institute of Technology, Pittsburgh to be an assistant in the Department of Natural Philosophy.

THE Carnegie Trust for the Universities of Scotland will announce in July next the allocation for the five years 1925-26 to 1929-30 of grants to universities and extra-mural colleges. For the quinquennium now expiring these grants amounted to 224,600*l.*, including 25,000*l.* for libraries, 156,000*l.* for new buildings and permanent equipment, and 43,000*l.* towards endowment of lectureships and other general purposes. Special additional grants were made last year towards the equipment of two hostels for women students at Glasgow (5000*l.*) and for the furnishing and equipment of a women students' union at Aberdeen (1500*l.*). Grants in 1923-24 for post-graduate study and research, including fellowships, scholarships, and grants-in-aid, amounted to 18,287*l.*. Assistance for students (average 12*l.* each) amounted to 54,000*l.* and voluntary refunds to 1126*l.*. A table of refunds since 1901 shows that the maximum (1623*l.*) was reached the year after the War.

APPLICATIONS are invited by the London County Council for two Robert Blair fellowships in applied science and technology, each tenable for one year and each of the value of 450*l.* The fellowships are for advanced study or research, tenable in the dominions, the United States or other countries. They are open only to British subjects. Further information and the prescribed application form (T.2.a 300) may be obtained from the Education Officer (T.2.a), The County Hall, London, S.E. 1, upon receipt of a stamped addressed envelope. Completed forms must be returned by June 30.

IN our issue of February 21, p. 284, announcement was made of the foundation, by the Commonwealth Fund, New York, of twenty fellowships for British graduates. The fellowships are tenable for two years in American universities and are each of the annual value of about 600*l*. The committee of award has now issued the first list of appointments. The distribution of the new fellows among British universities, including two institutions where a fellow has worked at two, is as follows: Oxford 6, Cambridge 4, Edinburgh 4, St. Andrews 3, Durham 2, and Belfast, Leeds, London, Manchester, and University College, Swansea, one each. Grouping the new fellows according to subject studied, the following are included: economics, geology, mathematics, medicine, chemistry and physics, two each, and engineering chemistry and botany, one each. The American universities to which the fellows will go are Harvard, Yale, Princeton, Columbia, Johns Hopkins, Cornell, and the universities of Pennsylvania, Chicago, Wisconsin, Minnesota, and California.

ON Saturday, Principal W. M. Childs, speaking at University College, Reading, upon the occasion of the annual conferment of the associateship of the College, announced that a letter had been received from the Clerk of the Privy Council stating that the Lords of the Committee of Council, after considering the further petition of the College for a charter under the title of the University of Reading, were prepared to recommend the grant of a royal charter by His Majesty in Council, subject to an assurance by the petitioners that they would take all possible steps to relieve the College of indebtedness and to increase still further its present income. The announcement was received with great enthusiasm by a large and representative audience. Speaking afterwards at a luncheon to the newly enrolled associates, the Principal stated that already, since the petition of the College was forwarded in January last, the income of the College had been substantially increased.

ON Tuesday, May 26, Sir Robert A. Falconer, President of the University of Toronto, delivered a lecture at the University of Edinburgh on "The United States as a Neighbour—Manners of Life and Thought." This was one of the lectures for 1925 of the Sir George Watson chair of American history, literature and institutions. Sir Robert Falconer discussed the effect of the environment of the new world and instanced the struggle which the settlers had in the new conditions of life, out of which issued virtues which have been reproduced in their descendants who kept moving out into the unknown regions of the West. The common school has been from early days one of the most powerful influences for the moulding of the character of the American people, among whom there is a deeply rooted conviction that the freedom of their democracy depends upon their education. On the whole, however, there is less freedom of speech than in Britain. The common school system in Canada took much from the practice and organisation of the schools of Massachusetts and New York, but was adapted so as to meet local requirements. In secondary education also Canada has adopted the American system, but Sir Robert stated that the results are not altogether satisfactory; pupils enter upon their high school work some two years too late, so that those who go on to the University at eighteen do not possess the liberal training necessary for recruits to the learned professions. The tie of a common language he considered to be the greatest and best of all influences moulding the life of Americans and Canadians to similar issues.

### Early Science at Oxford.

**June 7, 1687.** A letter from Mr. Humphrey to Mr. Lloyd, dated Llandowhyn May 26, 1687, giving an account of some Natural Curiosities from Anglisy was communicated.

Mr. Molineux his letter to Dr. Plot desiring some account of the great fall of Thames near London Bridge on May the 10th, which occasioned the Doctor to inform the Society that himself saw horses and also boys of 12 or 14 years of age pass ye River; that three parts of ye Channel was without water. The manifest cause of which was ye violence of the Winds which then blew at S.W.

Nux de Bhen, yelding an oyl much used by painters, and Semen Macalep, used in perfuming of gloves both from E. Indies, were communicated by Dr. Plot.

**June 8, 1686.** A Letter from Dr. Bagley to Mr. Musgrave was read; giving an account of the *Dissections* of four bodys.

Dr. Plot shewed the Society, the Curiosities following: A peice of Corktree nine foot long, and about five inches diameter, which grew in Cambridgeshire; A small stone changing colour according to the different reflections of light, appearing green and sometimes blackish; Oyl of Camphure made with water; A Liquor distilled from some bituminous strong scented earth digged at Hogsdon in Midlesex; *Labdanum liquidum* of a greenish colour.

**June 10, 1684.** Dr. Plot acquainted ye Society, that, haveing put some of ye *Natrôn* into a glass about a month since, he observed, that, at ye beginning of June, it was somewhat encreased in weight. He presented ye Society with a spirit of this salt mixed with salt of tartar; it was very volatile, urinose, and had something of an oiliness in its tast. He mentiond severall other experiments, which he had tried on this salt, but haveing not as yet put his last hand to them, he was desired to prosecute them, as he shall thinke fit, and bring in an account of them, when completed.

Dr. Plot also brought in an account of ye *weather* ye last month here at Oxon, taken according to Dr. Lister's Scheme: if this design be carried on, in ye severall quarters of ye land, it will inform us more particularly as to ye coasting of winds, and how rains etc depend on them. He also presented to us a pattern of a very rich *Gold-ore* from Hungary, lately presented him by Mr. Lawson, a Dane; it was of that sort, which is termed *Aurum statim suum*; it needs no refining, but may easily be separated from ye alabastine substance, with which it is mixed, barely by powdering.

Dr Smith communicated, and read, a discourse *de Longitudinum differentijs inveniendis*, composed many years since, by Dr. John Bainbrigg, formerly Savilian Professor in this University.

**June 12, 1688.** A Certificate from Mr. Morgan Jones a Minister, dated at New York Mar. 10th 1685-6. was read concerning some Natives of the West Indies near Cape-Ahas that understand the British Tongue.

A letter from Mr. Hillyer to our President dated Jan. 3 1687-8. was read, which gave a large account of the country of Cape Corse in Guinea and of some customes of the natives there.

Dr Plot communicated a stone that was brought out of Cornwall called the Soap-stone.

Mr. Musgrave gave an account that a very good sort of Vinegar is made thus; put 2 lb. of the best Mallaga Raisons cleansed into a gallon of spring water in an earthen jar covered with a slate and set in the sun for about two months in the heat of summer, or till it is sharp enough, then draw it off with a syphon without jogging.

## Societies and Academies.

LONDON.

**Royal Society, May 28.**—R. J. Ludford. (1) Cell organs during secretion in the epididymis. The Golgi apparatus hypertrophies and assumes different forms, according to the degree of secretory activity. There occur nucleolar extrusions, nuclear budding, and a differential staining of the nucleolus, while the mitochondria increase in number at the onset of secretory activity, and decrease during the course of secretion. Variations observed in the secreting cells in different tubules of the epididymis are probably indicative of variations in the degree of intensity of the secretory process. Secretory activity is maintained by the elimination of waste products, which is effected by nucleolar extrusions from the nucleus, and by amitosis followed by the discharge of a nucleus and part of the cytoplasm into the lumen of the tubule. Reconstruction of exhausted cells also occurs during a resting phase, while cells completely worn out are replaced, principally by the basal cells. (2) Nuclear activity in tissue cultures. The nucleoli of fibroblasts of the rat's kidney perform during life slow amoeboid movements. Occasionally a nucleolus approaches the inner surface of the nuclear membrane, and part of it is discharged into the cytoplasm, where it disintegrates. Also, a portion of the nucleus itself may be budded off, persist for a time, and then diffuse into the ground cytoplasm. These processes probably represent phases in the normal metabolic activity of the cell.—J. Needham and Dorothy Needham: The hydrogen-ion concentration and the oxidation reduction potential of the cell interior: a micro-injection study. Subject to certain assumptions, the cell-interior of *Amoeba proteus* has a hydrogen-ion concentration of approximately  $P^H$  7.6, and an oxidation reduction potential of between  $rH$  17 and 19.—F. W. R. Brambell: The oogenesis of the fowl (*Gallus Bankiva*). The Golgi apparatus, type 1, of the oocyte is demonstrated for the first time. It is shown to surround the centrosphere. An intrusion into the oocyte of Golgi apparatus, type 2, from the follicle cells takes place. The former, and possibly the latter, break up into fine granules and become dispersed throughout the cell during oogenesis. These granules probably persist as such, and produce the Golgi apparatus of each embryonic cell by a process of condensation. The mitochondria increase in number in the oocyte and form the *mitochondrial cloud*. The transitory *mitochondrial yolk-body* differentiates in the middle of this cloud. At a certain stage between the third and sixth week after hatching, a number of oocytes in the ovary of the chick enter upon a period of precocious growth, exhibiting remarkable abnormality in behaviour of their cytoplasmic inclusions and finally becoming atretic. This may represent the final degeneration of the primordial germ-cells.

**The Optical Society, April 16.**—J. Guild: The geometrical solution of colour mixture problems. Starting from the experimental fact that any colour can be uniquely expressed by a trichromatic equation, provided negative coefficients may enter, all problems of colour mixture are amenable to an exact system of geometrical calculation. The methods used obviate the introduction of stereographic projection and other geometrical complications. This simplification is effected by conducting the actual colour mixture part of any calculation in the quantity units of one trichromatic system, leaving the relative magnitudes of the various systems of units, where more than one

system is involved, to be accounted for by the introduction of suitable coefficients in the purely arithmetical part of the work.—J. W. Gordon: "The double square"—a new optical appliance based upon the "optical square." The optical square is a well-known arrangement of two mirrors for deflecting an optical axis through a right angle and obtaining an erect image. The double square is formed by the addition of a third mirror, which gives an inverted image and is so disposed with regard to the first two as to enable the image to be seen in adjacent but concentric fields, the one image simply reversed and in juxtaposition to the other. Such a combination may be used as an artificial horizon in the taking of altitudes or as a gun sight and is applicable to the sextant and the range-finder.—F. Van Neck: (1) The Hahn Goerz workshop microscope. This instrument is a shortened prism microscope giving an erect image of the object. A magnification of between 35 and 55 diameters is obtainable, the variation being effected by extending the ocular tube. An open sight is provided, by means of which the microscope can easily be directed to any particular spot. The microscope is carried on a horizontal bar which can move up and down on a vertical pillar, and movement in any direction is possible. The instrument can be used for examining objects of any kind which cannot be brought on to the stage of an ordinary microscope.—(2) The "Artisol" mirror arc lamp. This lamp is specially intended for the projection of cinema films. The carbons are at right angles to one another, the crater being directly exposed to the parabolic glass mirror. The light reflected from the mirror is collected by a large plano-convex lens. The arrangement of the carbons and the combination of glass mirror and large condenser ensures a much higher illumination per unit of current than in the ordinary pattern lamp.

**Linnean Society, April 23.**—R. J. Chittenden: *Primula* hybrids. The  $F_1$  between *P. acaulis* and *P. juliae* has a pink corolla, while those between *P. juliae* and *P. elatior* and between *P. juliae* and *P. officinalis* have the corolla yellow. A dominant colour inhibitor seems to be present in *P. elatior* and *P. officinalis* and absent from *P. acaulis*. These facts suggest that the garden *Polyanthus* may have risen from *P. acaulis* and *P. officinalis* or *P. elatior* hybrids by recombinations of their various factors.—M. A. C. Hinton: A vole from Montenegro, discovered in December 1921 by Dr. V. Martino. Martino's vole is a large species (head and body 130 mm.; tail 101, hind-foot 25.4; ear 18.5), long tail. In colour it is brownish-grey above when adult, bluish-grey when young, whitish below. Its feet are white and its tail conspicuously bicoloured, dark brown above, white below. It is referred to the genus *Dolomys*, described and hitherto only known from the Upper Pliocene of Hungary; Martino's vole is named *Dolomys bogdanovi*. The remarkable external characters and the extreme brachyodonty are generalised features of an archaic form which has managed to linger in Balkan seclusion.—John Parkin: A unique feature in the petal of *Ranunculus*, and its bearing on the phylogeny and taxonomy of the genus. Möbius, forty years ago, explained the cause of the high polish exhibited by the petals of yellow buttercups as follows: The upper epidermis of the petal has a perfectly smooth external surface, and its cells hold the yellow pigment in solution as a kind of oil. Below the epidermis is a layer of cells densely packed with minute starch grains. The whole structure is like a mirror. The epidermis with its clear yellow liquid acts as the gloss, and the starch layer as the reflector. This is substantially correct. Species with

glossy petals form a natural group, and most seem to have yellow flowers. The presence of starch in a few of the non-glossy species presents a difficulty in phylogeny. Perhaps starch in the mature plant is, as a primitive feature, retained and used as an adaptation in the species which have developed glossiness. The high polish of the petal of the yellow buttercup has been of advantage in attracting insect visitors to the flower, and thus been partly responsible in making this section of the genus, in contrast to the white group, cosmopolitan.—Kenneth Rees: Previous investigations into the distribution and ecology of marine algae in Wales.

Faraday Society, April 27.—E. A. Ollard: Adhesion of deposited nickel to the base metal. This work was undertaken to endeavour to measure the adhesion of deposited nickel to mild steel. A special method was evolved, the result of which shows an adhesion probably greater than 19 tons to the square inch.—H. Sutton: The brittleness of zinc-plated steel. Stream-line wires are embrittled by zinc plating. A deposit of zinc of not more than 0.0005 in. affords good protection against corrosion and permits the easy removal of the brittleness. Both cyanide and sulphate baths may be used, but the former is preferred on account of the superior protective qualities of the deposit. In either case the wires should be heated to 100° C. for thirty minutes. A rough surface before plating leads to severe embrittlement and impairs the recovery.—W. A. Naish: The partition of silver between lead and zinc. Melting was carried out in clay cylinders in a metal bath, heated electrically and with adequate stirring and temperature measuring arrangements, the cylinders being quenched in mercury. In dilute solution there is a distribution ratio  $\left( \frac{\text{Per cent. Ag in Zn}}{\text{Per cent. Ag in Pb}} \right)$  of approximately 302 at 550° C.; this is independent of the concentration of silver or the relative proportions of lead and zinc, but is dependent on the temperature, the deviation at higher concentrations than about 5 per cent. silver being probably due to the formation of compounds.—H. J. Poole: The elasticity of gelatin jellies and its bearing on their physical structure and chemical equilibria. The strain produced in gelatin jellies by the application of a steady stress is not a function of that stress alone but is governed by a time factor. The study of this time factor or "creep" suggests that the jellies are two-phase (solid-liquid) bodies. The creep is mainly due to a reversible flow of the liquid phase in the interstices of the solid phase and, to a lesser extent, to an irreversible plastic deformation of the solid phase. The solid phase is thought to have the form of a mesh of cylindrical fibrils or threads, and the material of these threads is in dynamic equilibrium with the water of the liquid phase, as a result of either a reversible hydrolysis or hydration, whereby the ratio of gelatin in the solid phase to that in the liquid phase becomes progressively less with rising temperature.—D. B. Macleod: (1) On some physical properties of water. The gain in volume, assumed to be due to association of the molecules in water, and the loss of free space, bear a simple relation to the change of association, and these two facts are used to explain all the anomalies of water connected with volume, compressibility, and viscosity. (2) On the relation between the viscosities of liquids and their molecular weights. Previously the author has shown that the viscosity of a liquid is inversely proportional to the free space within the liquid. The viscosities of liquids at a condition of equal amounts of free space relative to the total volume are now compared and

show that viscosity can be interpreted as a simple function of the molecular weight. Divergence from normality is ascribed to different degrees of molecular complexity.—E. K. Rideal: A note on the reduction potential of dicyanquinhydrone. The quinhydrone was prepared from equimolecular proportions of the quinhydrone and hydroquinone and the e.m.f. of the cell determined. The reduction potential was found to be 0.9712 volt at 25° C.

## DUBLIN.

Royal Irish Academy, April 27.—E. L. Hirst, A. K. Macbeth and D. Traill: The action of hydrazine on the halogen derivatives of malonamides and of acetoacetic esters. Monochloro-, monobromo-, and dibromo-malonamides are reduced by hydrazine hydrate at laboratory temperature, and the halogen derivatives of substituted malonamides react on warming. The case of dibromomalonamide is of interest as the final reaction product is the hydrazone of mesoxalamide. The  $\alpha$ -chloro- and  $\alpha$ -bromo-derivatives of ethyl ethyl-, propyl-, and benzyl-acetoacetates give as final products 3-methyl-4-ethyl-5-pyrazolone, 3-methyl-4-propyl-5-pyrazolone, and 3-methyl-4-benzyl-5-pyrazolone respectively, but halogen derivatives of ethyl acetoacetate give mixed products; the low percentage of evolved nitrogen in the last case is traced to this cause. The preparation of ethyl  $\alpha$ -chlorobenzoylacetate and its conversion into ethyl aminothiazolecarboxylate were described.

## PARIS.

Academy of Sciences, April 27.—Jean Tilho: The order of magnitude of the variations of depth and extent of Lake Chad.—A. Bigot: The presence of Trilobites and Archæocyathideæ in the Cambrian layers in the neighbourhood of Carteret (Channel).—Gaston Julia: Quasi-analytical functions and integral functions of zero order.—M. T. Huber: The bending of a flanged plate.—P. Chofardet: Observations of Orkisz's comet (1925 c) made at the Observatory of Besançon with the *coudé* equatorial. Positions given for April 19, 22, and 23. On April 22 the comet was estimated to be of the 8th magnitude, showing as a circular nebulous cluster, about 8' diameter, with a strong central condensation.—H. Eyraud: The theory of the electromagnetic field and atomic radiation.—Léon Brillouin: Surface tension: the interpretation of the Eötvös relation.—C. E. Guye, P. Mercier, and J. J. Weiglé: The explosive potential in carbon dioxide at high pressures. The experimental results of several years' work are given, showing the explosive potential in volts for pressures between 1 and 20 atmospheres and for distances between the electrodes varying between 0.5 and 5 mm.—R. Forrer: An artificial magnetic anisotropy of nickel. The phenomena of discontinuity.—E. Estanave: Contribution to the realisation of integral photography.—H. Ikeuti: The beta rays produced in air by homogeneous X-rays of short wave-length. Measurements of the lengths of the trajectories of the two types of beta rays, photo-electrons, and fish tracks (C. T. R. Wilson). The results are in general agreement with those of Wilson and Compton.—Albert Arnulf: The ionisation of potassium vapour under the influence of visible light. Experiments showing that under the influence of ordinary (not ultra-violet) light a small number of electrons and positive ions are set free.—Roger Grandgérard: The "Bertillonage" of modern pictures by radiography. A radiograph of a picture furnishes an exact proof of identity. It is suggested that a radiograph of a picture, taken under certain prescribed conditions, should be deposited officially, a duplicate being

retained by the artist. This would suffice to decide any question of authenticity in the future.—H. Forestier and G. Chaudron: The transformation points of solid solutions of alumina or chromic oxide in ferric oxide.—W. Mestrezat and Mlle. Y. Garreau: Experimental contribution to the study of the transport of electrolytes. The mobilisation of the ions by intermolecular exchanges.—Georges A. Le Roy: A medieval weapon damascened with tin. Ancient weapons, inlaid with gold or silver, are well known, but inlaying with tin during medieval times in Europe has not hitherto been noted. The épée examined by the author was found to be inlaid with tin.—Raymond Charonnat: The potassium chlororuthenates. The brown chlororuthenate of Claus and Rutbier and the red salt obtained by Lewis Howe have been accepted as a case of isomerism not in agreement with Werner's theory. It is shown that these two salts are not isomers, since ruthenium is tetravalent in the brown salt and trivalent in the red salts. This removes a supposed case of isomerism incompatible with the theory of Werner.—Max and Michel Polonovski: The oxyserenic derivatives.—Const. Dosios and Theod. Tsatsas: The nitro products of diphenylglycolic ether.—Raymond Delaby and Jean Marc Dumoulin. The isomerisation of the vinylalkylcarbinols  $\text{CH}=\text{CH}-\text{CH}(\text{OH})\cdot\text{R}$  into ethyl-alkylketones  $\text{C}_2\text{H}_5\cdot\text{CO}\cdot\text{R}$ . Vineylethylcarbinol is converted by copper at  $296^\circ\text{C}$ . into the isomeric diethylketone. The next two higher homologues are similarly converted into the corresponding ketones.—F. Kerforne: The contact of the Vilaine sheet with its substratum.—C. E. Wegmann: A delayed phase of the Scandinavian Caledonian chain.—A. Goris and M. Metin: The chemical composition of a hybrid of *Aconitum Anthora* and *Aconitum Napellus*. The alkaloids peculiar to each species (anthorine and aconitine) are found together in the hybrid.—Paul Gillot: The characteristics of some oils from Euphorbiaceæ. Mercurialis and Euphorbia are not only characterised by their botanical affinities, but also by the similar physical and chemical characters of the oils extracted from their seeds. These oils are very similar to linseed oil.—E. and G. Nicolas: Observations on the influence of urea, thiourea, and allylthiourea on the higher plants.—Edouard Fischer: The constitution of the green gland of the crayfish.—Lucien Semichon: The action of alcohol on the selective faculty of yeasts in the fermentation of grape musts.—Léon Blum and Maurice Delaville: Researches on the mechanism of acidosis.—L. Panisset and J. Verge: The presence of spirochætes in dogs attacked with hæmorrhagic gastro-enteritis.—Yves Kermorgant: The etiology of mumps

## ROME.

Royal Academy of the Lincei, March 15.—T. Levi-Civita and U. Amaldi: Conditions for the ensurance of the independence of the arguments in the Hamiltonian expression for varying action.—Leonida Tonelli: Singularity of the solution of an ordinary differential equation.—F. Zambonini and G. Carobbi: Lanthanum thallous sulphates. The three compounds,  $\text{La}_2(\text{SO}_4)_3$ ,  $4\cdot5\text{Ti}_2\text{SO}_4$ ;  $\text{La}_2(\text{SO}_4)_3$ ,  $3\text{Ti}_2\text{SO}_4$ ; and  $\text{La}_2(\text{SO}_4)_3$ ,  $\text{Ti}_2\text{SO}_4$ ,  $2\text{H}_2\text{O}$ , are found to exist.—Secondo Franchi: Fundamental stratigraphical and palæontological data for the secondary age of the calc-schists and the hypothesis of a great overthrust of the mass of these rocks in the Franco-Italian Alps.—Achille Russo: Impure gametogens, impure gametes, and accessory conjugations in *Cryptochilum echini* Maupas.—Enrico Bompiano: A theorem of comparison and a theorem of singularity for the differential equation  $y' = f(x, y)$ .—Letizia Onali: A theorem on the surface of the minimum

order passing through an oblique curve.—D. J. Struik: Mathematical work of Paul of Middelburg.—Emilio Oddone: The resistance offered by the earth's surface to movements of the air.—G. Carobbi: Synthetic praseodymiferous chlorovanadinite. Reference to Prandtl and Grimm's recent work on element No. 61. The author's failure to justify the assumption that praseodymium exists in a quinquivalent form isomorphous with quinquivalent vanadium furnishes no support for the arrangement of the rare earths given in Prandtl and Grimm's periodic system.—U. Sborgi: An electronic theory of the anodic behaviour of metals, especially of those exhibiting phenomena of passivity.—U. Pratolongo: Alkaline chlorosis of the vine. The results of preliminary experiments indicate no causal connexion between the high alkalinity of the soil or its tendency to produce chlorosis and the presence, abundance, or fineness of the calcium carbonate it contains.—Antonio Cavinato: Studies on quartz: Quartz crystals from Val Maggia and their interesting pseudo-hemimorphic habit.—Enrico Clerici: Fusion mixture for isopyknermic analysis. Mixtures of thallium formate and fluoride give liquids of specific gravity  $4\cdot20$  at  $20^\circ\text{C}$ .,  $5\cdot38$  at  $100^\circ\text{C}$ ., and  $5\cdot40$  at  $110^\circ\text{C}$ .; such mixtures exhibit marked fluidity and pass rapidly through filter-paper.—Renato Santucci: Contribution to the study of the post-embryonic development of the Scyllaridea of the Mediterranean.—P. Pasquini: First formation of the pectin in the development of the eye of *Gallus domesticus*.

## WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 11, No. 3, March).—G. L. Clark and W. Duane: The relative intensities of fluorescent and scattered X-rays. The scattered and tertiary radiation due to tungsten X-rays, for secondary radiators of atomic weight near that of molybdenum, are extremely weak compared with the fluorescent radiation. The source of the powerful radiation found in earlier experiments is unknown.—W. Duane: Note on the quantum theory of the reflection of X-rays. The assumption that only the total fluorescent radiation from an atom quantises its momentum with the crystal leads to results not justified by experiment.—G. N. Lewis: A new principle of equilibrium. Corresponding to every individual process there is a reverse process, and in a state of equilibrium the average rate of every process is equal to its reverse process. This is termed the Law of Entire Equilibrium. In a state of equilibrium, there is no essential difference between backward and forward direction in time; time thus loses its unidirectional character.—J. C. Walker: Studies on disease resistance in the onion. So far as smudge and neck-rot are concerned, immunity appears to be related to the presence of flavone or anthocyan colouring matter in the outer scales. Black mould attacks both coloured and uncoloured varieties.—W. J. Luyten: Notes on stellar statistics; (iv) on the relation between the mean values of the  $v$  and  $\tau$  components of proper motion.—Cecilia H. Payne: Astrophysical data bearing on the relative abundance of the elements. The temperature of disappearance of a line in stellar spectra is a function of the relative abundance of the element in question (Fowler and Milne). Assuming among other things that stellar atmospheres are uniform and that the effects of nuclear fields are negligible at stellar pressures and temperatures, computations from a homogeneous collection of spectra indicate that the relative abundance of atomic species in the stars and in the earth's crust is of the same order. Zinc is an exception, and the stellar figures for hydrogen and helium are improbably high.





SATURDAY, JUNE 13, 1925.

## CONTENTS.

	PAGE
Work and Influence of the Royal Botanic Gardens, Kew . . . . .	897
Egyptian Mathematics —I. By Prof. D'Arcy W. Thompson, C.B., F.R.S. . . . .	899
Nature and Mind. By Prof. H. J. W. Hetherington . . . . .	903
The Energetics of the Living Cell. By Prof. Arthur Harden, F.R.S. . . . .	905
Our Bookshelf . . . . .	906
Letters to the Editor :	
The Taungs Skull.—Prof. W. J. Sollas, F.R.S. . . . .	908
The Discovery of Benzene.—Dr. E. H. Tripp . . . . .	909
Double Impacts by Electrons in Helium.—George Glockler ; E. G. Dymond . . . . .	909
Possible Effects on Marine Organisms of Oil Discharged at Sea.—Dr. J. H. Orton . . . . .	910
Salps and the Herring Fishery.—Prof. W. C. McIntosh, F.R.S. . . . .	911
Vernier Wireless Time-signals.—S. K. Banerji ; Dr. Andrew C. D. Crommelin . . . . .	912
The Sound of Lightning.—Dr. W. Lawrence Balls, F.R.S. . . . .	912
Hypothecate . . . . .	912
The University of Bristol. OPENING OF NEW BUILDINGS . . . . .	913
Metal Resources and the Constitution of the Earth. By T. C. . . . .	914
The Discovery of Benzene. By Prof. Jocelyn F. Thorpe, C.B.E., F.R.S. . . . .	915
Current Topics and Events . . . . .	917
Our Astronomical Column . . . . .	921
Research Items . . . . .	922
The Origin of Species as revealed by Vertebrate Palæontology. By Dr. Henry Fairfield Osborn . . . . .	925
Periodicities and Predictions . . . . .	926
The Royal Observatory, Greenwich. ANNUAL VISITATION . . . . .	927
University and Educational Intelligence . . . . .	927
Early Science at Oxford . . . . .	928
Societies and Academies . . . . .	929
Official Publications Received . . . . .	932
Diary of Societies . . . . .	932

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## Work and Influence of the Royal Botanic Gardens, Kew.

COAL, oil, iron and steel enter so largely into the working of the complicated civilisation of the present that it is apt to be overlooked that they are but the tools for collecting, distributing, elaborating, protecting and too often destroying the organic products on which the life of man, his culture and most of his comforts depend. Directly or indirectly, these products are the gift of the living green mantle of the earth. The spread of population that has taken place concurrently with the evolution of modern industry has brought about great, and is likely to bring about still greater, changes in the earth's vegetation. Some of those transformations, such as the displacement of the native flora of prairie lands by cereals and other crops, are inevitable and, from the human point of view, beneficial; others, like the reckless destruction of forests in many parts of the world, have wasted the present and heavily mortgaged the future. The sooner the problem of ensuring a rational utilisation of the vegetation of the earth is faced in more organised fashion than at present the better.

It is of peculiar importance to the British Empire, for no other power holds such vast estates, with every variety of physiographical and other conditions, and almost boundless potentialities of production. These potentialities can be developed to the best advantage only on a foundation of exact knowledge of all the conditions, and one of the most important elements of this foundation is a thorough scientific survey of the vegetation of the Empire. Although the desire for increase of knowledge of plants was stimulated by the travels and voyages of discoveries from the fifteenth century onwards, and their resulting introductions of new plants and products into Europe, a scientific survey was impossible until a rational system of nomenclature was devised by Linnæus, about the middle of the eighteenth century. Thereafter the botanical survey of the Empire began and has been in progress ever since.

In British colonies and tropical possessions the benefits expected from the introduction of foreign, and the improvement of native, plants, and the need of centres where such plants could be experimentally cultivated, led to the foundation of botanic gardens in the West Indies, India, Australia, the Straits Settlements and Ceylon. These and other overseas gardens have played a very useful part in the botanical survey of the Empire, but it may be doubted if the practical importance of these institutions is appreciated as it should be, for in too many cases their history is one of cramped finances, under-staffing and scanty equipment.

Still, in founding them at all the governments concerned showed more enlightenment than was evident in the home government for many a year afterwards, for while this activity was being shown abroad the home government remained indifferent. Fortunately, this official neglect was counterbalanced by the interest in botany shared by Royal personages and men of position and wealth, and it is to such interest that the British Empire owes the foundation of the Botanic Garden that more than all the others has contributed to our knowledge of the Empire's vegetation.

The small Physic Garden, which Princess Augusta, with the advice of the Earl of Bute, formed at Kew in 1760, was greatly enlarged after her death in 1772 by her son, George III., and Joseph Banks—not long returned from his famous voyage with Cook—placed in advisory charge. For almost half a century thereafter, the king royally supported Banks in his schemes for the enrichment of the Royal Botanic Garden—as it had now become—and the botanical exploration of the lands beyond Europe. In addition to the support of the king, the interest, wealth, and influence in scientific circles of Sir Joseph Banks, the impersonal advantages of its geographical position contributed to the early pre-eminence of Kew. In tropical gardens the difficulties in controlling temperature restrict the introduction of plants to those of similar climates, while in the investigation of the vegetation of the territories they serve, most of them were and are embarrassed by a wealth of material far beyond their means to work out unaided. Here Kew was—and is—of signal service, for it could introduce plants from and to all parts, while the comparative poverty of the British flora left the Garden all the more free to extend its interests and help beyond the British Isles.

Natural advantages, however, avail not without personality and means, as Kew discovered with the passing of the king and Sir Joseph Banks in 1820. For the next twenty years the Royal Gardens declined almost to extinction, from which they were rescued only by the interest of the young Queen Victoria and an agitation against their proposed abandonment that led to a committee being appointed to advise on the future of the Gardens. The committee—which included Lindley and Paxton—commented rather severely on the lack of unity of purpose and of system in the control of the overseas gardens and advocated the placing of them all under the control of a central National Botanic Garden as the best means of co-ordinating the investigation of the vegetation of the Empire and of applying such investigation to medicine, commerce, agriculture, horticulture and industry. Although the wisdom or even the feasibility of placing all the gardens of the outer lands under the official control of

a central garden may be doubted, there can be no question of the advantages of co-operation and co-ordination, and there is still a vast field for cultivating both.

Although the Report of the Committee did not result in the establishment of an Imperial Botanical Survey, it brought about the transformation of Kew from a private Royal Garden into a public one, and the appointment of the elder Hooker as its first director. Since then Kew has, thanks in no small degree to the personality of its directors, proved a most valuable asset to the British Empire. On the purely scientific side, and considering only the Empire lands, Kew can point to the published floras of Australia, New Zealand, Hongkong, the Malayan Peninsula, Ceylon, India and most of its Provinces, Mauritius, the Cape, tropical Africa and the West Indies as amongst the fine fruits of its botanical leadership. On the applied side its influence on horticulture and on the introduction and cultivation of economic plants has been far-reaching and profound. Of the latter the vast growth of the rubber industry is a notable instance. It may be doubted, however, if the great practical importance to the Empire of the scientific activities of Kew and the scope for extending these are sufficiently appreciated.

Possibly one reason for this is the unobtrusive way in which the work has been carried on and the reticence practised in publishing information as to the Gardens' activities. It is, therefore, a move in the right direction that the old practice—obsolete for so many years—of publishing a review of the year's work, has been recommenced. This review, which appears under the guise of Appendix II., 1925, of the *Bulletin of Miscellaneous Information*, gives within 31 pages a concentrated account of the work of the Gardens during 1924. Almost every page mirrors the world-wide range of Kew, for whether it be the Gardens proper, the Museums, the Jodrell Laboratory or the Herbarium and Library, there is scarcely a land between the poles that does not give or take.

The offerings, in fact, have been for so many years in excess of the means of dealing with them that Kew has suffered from chronic indigestion. While it is good to learn that some relief has been given to this condition by a temporary addition to the Herbarium staff, it is as well to recognise that this is merely palliative. Proper treatment of the condition involves a strengthening of the whole organisation for botanical survey work—in the widest sense—throughout the Empire. The wider aspect of the problem which forced itself upon the attention of the Committee of 1838, was again examined by the Imperial Botanical Conference of 1924, whereat many excellent suggestions were advanced.

The extent to which these suggestions are likely to bear fruit will depend largely on the realisation by the home and overseas governments of the great practical importance of the Survey and on the recognition by those who have made and are making fortunes in jute, tea, cotton and other textiles, soap and such-like products, of what they owe to botanical investigations. As Dr. Burt Davy pointed out at the Conference, the home government has good reason to give generous aid to the Survey, as England depends so much on the overseas parts of the Empire for raw products and foodstuffs. Yet the total annual expenditure on Kew is little more than equal to the interest on the proposed government guarantee for the British Empire Exhibition. If England can find such a guarantee for an Exhibition so largely concerned with the organic products of the Empire, it should surely be possible to allow a more liberal endowment than is at present available for the investigation of the ultimate source of all such products. The support of the Survey should appeal no less to the overseas governments as a fruitful aid in the development of their vegetative resources and so of their populations and products. Yet at Kew, the botanical centre of the Empire, only India and the combined West African colonies are represented on the scientific staff by a single botanist each.

The fact that most of the botanical gardens of the Empire are government institutions is not an unmixed advantage, for government financial departments are apt to judge them rather too much by the irrelevant test of direct revenue and to treat them as mere luxuries to be reduced when opportunity offers, while the public scarcely thinks of them as requiring financial aid like universities, medical schools and hospitals. Governments may reasonably be expected to provide for an increase in staff and equipment and the institution—where it is not already in existence—of some system of study leave, such as the Indian scientific services enjoy, to enable members of the scientific and horticultural staffs to enlarge their experience and increase their usefulness.

But beyond such provision as any government within the Empire is likely to give, there remains abundant scope for private aid in the endowment of travelling fellowships, of exploration of the less known parts of the Empire, of lectureships on various aspects of the vegetation of the Empire, of libraries, of museums, of laboratories and of publications. For the exercise of such public-spirited liberality the Royal Botanic Gardens, Kew, which owe their enlarged foundation to the enlightened munificence of an English king, stand as a splendid stimulus and example.

## Egyptian Mathematics.

*The Rhind Mathematical Papyrus: British Museum 10057 and 10058.* Introduction, Transcription, Translation, and Commentary by Prof. T. Eric Peet. Pp iv+136+24 plates. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1923.) 63s. net.

### I.

PROF. PEET'S beautiful book is written for the Egyptologist and the mathematician, but not only for them. It is also for the man in the street—in such a street as runs through any university town; for the Rhind papyrus is one of the ancient monuments of learning. The famous scroll was bought in Luxor in 1858 by a Scottish lawyer and antiquary, from whose keeping it passed into that of the British Museum. There, in 1867, Lenormant examined it and referred it to the XIIth dynasty; Birch, and Brugsch the lexicographer, again examined and in part described it; and Eisenlohr (a colleague of Moritz Cantor's in Heidelberg) published a full and useful description,<sup>1</sup> based on facsimiles lent by the Museum—"a courtesy which he repaid by publishing a tracing of them without authority." The Museum issued an almost perfect facsimile in 1898, with an introduction by Sir E. A. W. Budge (cf. NATURE, vol. 59, p. 73); and at various times the papyrus has been studied by many scholars, by Hultsch, Cantor, and Lepsius, Griffiths and Rodet, Favaro, Gino Loria and others. Prof. Peet is a born Egyptologist; he has made himself a mathematician; he has "combined his information." His labours crown the exhaustive investigation of the papyrus, and he gives us its whole story in the most attractive and most readable form; he might have given us, perhaps, a fuller bibliography.

As it lies in the British Museum the papyrus is in two parts with a gap between; some one (Prof. Peet does not tell us who) had the good fortune and the insight to discover that the gap was in part filled up by certain fragments in the possession of the New York Historical Society, once the property of Edwin Smith, and probably obtained by him together with a famous medical papyrus which bears his name. These New York fragments help to complete a table of fractions of which we shall speak directly, a table which is of cardinal importance for the understanding of the whole work.

The Rhind papyrus was written under a certain Hyksos king who reigned somewhere between 1788 and 1580 B.C., but the scribe states that he copied an

<sup>1</sup> "Ein mathematische Handbuch der alten Agypten," 1877.

older document of the XIIth dynasty, in a reign which can be more precisely dated as between 1849 and 1801 B.C.—some twelve or thirteen centuries before Pythagoras; this date is much the same as that of other important mathematical papyri, such as the Berlin fragment and the Moscow papyrus. Whether in its time it was a great work or a minor one, a compendium for the scholar, a manual for the clerk, or even a lesson-book for the schoolboy, we do not know; but a popular or standard work of its kind, its re-issue after more than a hundred years shows it to have been. Were it only an elementary schoolbook it would still illustrate a saying of De Morgan's—we have it in the preface to his work on early "Arithmetical Books"—that "the most worthless book of a bygone age is worthy of preservation"; we may be thankful for this one, over and over again.

According to our own vague impressions, we are apt to minimise or to magnify what the ancients, and not least what the Egyptians, may or must have known; we are seldom justified, we must always be cautious, in saying that the Egyptians (or the Greeks, as the case may be) did *not* know this or that. At the very least this papyrus tells us many things which they did know, and shows what were doubtless their common ordinary ways of solving their problems. But mathematics is so curious a thing, the gift of numbers is so singular a mental faculty, that I should be loath to believe that there were not men in ancient Egypt who could do far more difficult calculations than any which this papyrus reveals, and do them by other methods than are set forth here.

How much earlier than this XIIth dynasty papyrus must we go to find the beginnings of Egyptian mathematics? This is one of the questions discussed, all too briefly, by Prof. Peet in his fascinating introduction. Even in the first dynasty a notation was in vogue up to the sign for a million; under the IVth dynasty we find the same land-measures in use as are employed in the Rhind papyrus: the origin of learning, the beginnings of science and of the arts, recede from us the more we follow them. But so far as we can see, and so far as Plato and other Greeks have told us, the ancient science of the Egyptians ran its long course on narrow lines. There may have been dreamers among them, but (unlike Joseph) they did not tell their dreams; what we know of their wisdom the scribes have told us, and the scribes were practical men. We have no trace in Egypt of such speculative mathematics as occupied the School of Pythagoras, no discussion of first principles, no philosophy like Plato's, of which mathematics was a part. Even the Rhind papyrus is scarcely a treatise at all; it is a collection

of examples, and the examples are of a strictly practical kind. For this very reason they seem strangely familiar to us; they are everyday, world-wide problems, of so many loaves to so many men and such like; they are often all but word for word the selfsame exercises which we and our children have done at school. They seem to me just such simple calculations, "combining amusement with instruction," as Plato says "the sons of gentlemen should learn, as they do in Egypt."

The Egyptologist has learned much in the last few decades, and the mere translation of the text is far more certain in Prof. Peet's hands than in those of its first students. There is a curious instance of the early difficulties of the translator—Prof. Peet only half relates or merely hints at it. The text of a certain problem, all but the last in the book, led Eisenlohr to assert that the powers of a number had specific and curious Egyptian names—the scribe, the cat, the mouse, etc. Favaro, for one, was suspicious; he called this "una denominazione così strana da far dubitare che l' Eisenlohr abbia rettamente interpretato a questo punto il papiro"; and Cantor said he could neither verify nor disprove the statement. Léon Rodet, reading the *Liber Abaci* of Leonardo Pisano (or Fibonacci, as we usually call him), was struck by the resemblance of the series to a problem there: *Septem vetulae vadunt Romam; quaelibet habet burdones* (i.e. *donkeys*) *septem*, etc. Why, it is just the medieval setting of our own immortal "As I was going to St. Ives"; and so they had it in Egypt also: "[In such a town] were seven scribes<sup>2</sup>; each scribe had seven cats; each cat caught seven mice"; and so on.

The Egyptian notation was a decimal one, as was that of all ancient peoples save the older Babylonians, but the Egyptians had signs only for the unit, for 10, 100, and so on up to 100,000, each of these signs being repeated the required number of times; it follows from this that addition, or "putting on," and subtraction or "breaking off," were merely mechanical processes. Multiplication and division were performed under strict limitations. To multiply by 10 was easy, for it only meant turning the unit-symbols into 10's, and so on; yet this easy method was not always employed. With very few exceptions the Egyptian multiplied by two, and by no other number: his multiplication table, the multiples which he knew by heart, would seem to have stopped at two-times. He employed the processes of *duplication* and *dimidiation*, rather than of multiplication and division; and books of arithmetic maintained the same distinction at least up to the sixteenth century. He kept on doubling; and he could

<sup>2</sup> Prof. Peet now translates "seven houses."

then pick out, or tick off, from the successive products any multiple he pleased. Thus to multiply  $7 \times 11$ , he would write down

$$\begin{array}{r} / 1 \quad 7 \\ / 2 \quad 14 \\ 4 \quad 28 \\ / 8 \quad 56 \\ \hline 11 \quad 77 \end{array}$$

He added together the once, twice, and eight times we add together the once and the ten times; that is wellnigh all the difference. Moreover, when we do our sums by "practice," we are using a very ancient method and doing them almost exactly as the Egyptians did.

Why, when he started with a symbol for 11, consisting of a unit and a ten, he did not at once write down seven units and seven 10's, and so obtain his symbol for 77, we do not know—and we are left wondering; but the method here exemplified is the one which runs all through the book. It seems impossible to believe that the old mathematician was really limited to this cumbrous method; and it is tempting, therefore, to suppose that he inculcated it for a deeper reason. Rodet believes that his purpose was to demonstrate a theory of proportion, to show that two quantities retain the same relation to one another, whatever identical operations of multiplication and division they have both undergone.

The above method of multiplication could not go far, and the converse process of division could not be effected at all, without constant use of fractions; and these the Egyptian handled with extraordinary skill, though again his limitations were severe. While he could easily express any whole number, he had no notation for fractions (with the single exception of  $\frac{2}{3}$ ) other than as aliquot parts, *i.e.* as fractions the numerator of which is unity—fundamental fractions, as Schiaparelli called them; all other fractions had first of all to be reduced to these, and how to do so, how to reduce any fraction to a series where each has unity for its numerator, is a problem which has not yet ceased to interest mathematicians. The Greeks (with certain exceptions) did precisely the same thing; thus Archimedes writes  $\frac{1}{2}$ ,  $\frac{1}{4}$ , for  $\frac{3}{4}$ , and Hero writes  $\frac{1}{2}$ ,  $\frac{1}{17}$ ,  $\frac{1}{31}$ ,  $\frac{1}{51}$  when he wants to express  $\frac{31}{1}$ ; moreover, the Greeks had special signs for  $\frac{1}{2}$  and  $\frac{2}{3}$ , but for no other fractions.

The Egyptian kept by him a table of these equivalent fractions, which table, as Cantor says, we can only suppose to have grown slowly into shape as the result of protracted labours. How it was achieved at all is a question elaborately discussed by Cantor, Eisen-

lohr, Hultsch, Griffiths, and others, and now by Prof. Peet; but there seems to be no clear and certain answer yet, and Cantor confesses openly to failure. The Rhind papyrus carries the list from  $\frac{2}{3}$ ,  $\frac{2}{7}$ , etc., as far as  $\frac{2}{101}$ .  $\frac{2}{3}$  was easily resolved into  $\frac{1}{1} + \frac{1}{3}$ ;  $\frac{2}{7}$  into  $\frac{1}{1} + \frac{1}{7}$ , etc.; but some of the resolutions were of necessity complicated, *e.g.*  $\frac{2}{61} = \frac{1}{10} + \frac{1}{15} + \frac{1}{30} + \frac{1}{60}$ ; or  $\frac{2}{89} = \frac{1}{10} + \frac{1}{55} + \frac{1}{551} + \frac{1}{901}$ . The papyrus explains them all, one by one, for example:—

Divide 2 by 13:

$$1\frac{1}{2} + \frac{1}{8} \text{ is } \frac{1}{2}. \quad \frac{1}{4} \text{ is } \frac{1}{2}. \quad \frac{1}{8} \text{ is } \frac{1}{101}.$$

Working out:

$$\begin{array}{r} 1 \quad 13 \\ \frac{1}{2} \quad 6\frac{1}{2} \\ \frac{1}{4} \quad 3\frac{1}{4} \\ / \quad \frac{1}{8} \quad 1\frac{1}{2} + \frac{1}{8} / \\ / \quad \frac{1}{32} \quad \frac{1}{4} / \\ / \quad \frac{1}{101} \quad \frac{1}{8} / \end{array}$$

13 has been split up into parts, first by successive divisions by 2, afterwards by the scarcely more difficult operation of taking  $\frac{1}{13} = 1$ , and therefore  $\frac{1}{13} = \frac{1}{4}$ . The next step is tacitly assumed: namely, to pick out from the divisional parts of 13 such as, taken together, amount to 2; and the corresponding fractions of 1, standing opposite to them, are the series required.

It may well be that what is here set forth does not purport to be an explanation of the method, but merely a proof or verification of the result stated; so also in many other problems with which the papyrus deals—the answer is given, and the working shown is that required to check or confirm it. Prof. Peet, however, thinks that the setting out of the proof gives us a clue to the way in which the result was actually obtained; the method was clearly one of trial and error. The Egyptian "had grasped the fact that the problem consisted in breaking up 2 into the sum of several quantities, each of which would divide without remainder into the given denominator"; and accordingly, Prof. Peet shows us, alongside of the resolved fractions, the corresponding resolutions of 2—as being the first step towards the discovery of the former.

We, I imagine, would proceed otherwise. We should probably begin by multiplying the numerator and denominator of our fraction  $\frac{2}{a}$  by some number, greater than  $a$ , until we found the new numerator resolvable into parts, each a convenient sub-multiple of the new denominator. Thus  $\frac{2}{13} = \frac{2 \times 7}{13 \times 7} = \frac{14}{91} = \frac{1}{7} + \frac{1}{91}$ ; and this seems a simpler result than that arrived at by the Egyptian; it seems to prove that this was not the Egyptian's way. It is curious that this is the very

result we get by the method shown in the late Greek papyrus of Akhmim.<sup>3</sup>

But the more we look at the Egyptian's table of resolutions the more satisfactory and even elegant does it appear; it is only very seldom that we can suggest a better alternative. There is no simpler resolution, for example, of  $\frac{2}{9}$  than  $\frac{1}{9} + \frac{1}{6} + \frac{1}{18}$ , which is what the table gives. For  $\frac{2}{3}$  we might prefer  $\frac{1}{3} + \frac{1}{4}$  to  $\frac{1}{3} + \frac{1}{12}$ , which latter is what the Egyptian gives; but he is probably right in avoiding the higher denominator. In this case he has resolved 2 into  $\frac{7}{6} + \frac{5}{6}$ , or, as he writes it,  $1\frac{1}{6} + \frac{1}{3}$ : he adds a note to show that he realised he was dealing with  $7 \times \frac{1}{6}$ , and  $5 \times \frac{1}{6}$ . It is one of the cases which seem to show that he was not hampered by lack of skill, so much as by his strictly limited and conventional notation.

The last case of all, namely,  $\frac{2}{101}$ , is an interesting one; the solution given is  $\frac{1}{101} + \frac{1}{202} + \frac{1}{303} + \frac{1}{404}$ , a form of resolution differing from any other in the long list, for here, and here alone, one of the fractions is just one half of, and thus has the same denominator as, the fraction to be resolved. Prof. Peet remarks that "mathematically the result is surprising and disappointing; it may be surmised from this feeble ending that the mathematician was here at the extreme range of his ability." I do not think so; the solution seems to me an elegant one, and what is more, *there is no other* which does not involve very high denominators; the simplest, and much the simplest alternative which I can discover, is  $\frac{1}{60} + \frac{1}{40} + \frac{1}{15}$ , but this last denominator is much higher than any other which the table admits or contains.

From the Table of Resolutions of  $2/(2n+1)$ , we pass to problems where so many loaves have to be divided among ten men; the rule as to aliquot parts is still adhered to, and the problems are little more than simple exercises on the preceding table. From these we go on to somewhat more difficult but closely related exercises, involving the addition and subtraction of fractions; these are what are called the *skm*, or *sekhem*, problems, *i.e.* problems of *completion*. "Democritus spent a quarter of his life as a boy, a third as a youth, a fifth in manhood, and he has been an old man for thirteen years; how old is Democritus?" This is a well-known problem in the Greek Anthology; I take it to be a typical *sekhem* problem. Those which our papyrus gives are in plainer form. For example, given the series  $\frac{1}{4} + \frac{1}{8} + \frac{1}{10} + \frac{1}{20} + \frac{1}{40}$ , we are asked to complete it to  $\frac{2}{3}$ ; in other words, to subtract it from this latter fraction. Most of the working is omitted. The fractions are first replaced by the numbers  $11\frac{1}{4} \cdot 5\frac{1}{2} + \frac{1}{8} \cdot 4\frac{1}{2} \cdot 1\frac{1}{2} \cdot 1$ , which are numerators corresponding

to a common denominator 45. The complete series is then stated as follows:

$$\begin{array}{cccccccc} \frac{1}{4} & \frac{1}{8} & \frac{1}{10} & \frac{1}{20} & \frac{1}{30} & \frac{1}{40} & \frac{1}{45} & \frac{1}{45} \\ 11\frac{1}{4} & 5\frac{1}{2} + \frac{1}{5} & 5 & 4\frac{1}{2} & 1\frac{1}{2} & 1\frac{1}{5} & 1 & 15 \end{array}$$

"making 1,"

and  $\frac{1}{9} + \frac{1}{40}$  is seen to be the required "completion" of the original series to the sum of  $\frac{2}{3}$ . The phrase "common denominator" is, of course, modern, for the Egyptian has no equivalent word; nor indeed was it precisely a "common denominator" which he sought and used. In the above example the common denominator would be 360; the Egyptian was content with the denominator 45, for, though the corresponding numerators were often fractional, they were simple fractions such as gave him no trouble to employ.

Rodet has emphasised more than Prof. Peet the distinction between this operation and ours; and he has shown in a very interesting way how what was precisely the old Egyptian method survived in Jewish and Moorish arithmetic. The Hebrew *môré*, the "ruler" or "guide," and the Arabic *mokhraj*, or "block"—out of which what we require may be hewn—had a wider meaning than our "common denominator"; it was anything to parts of which our fractions may be considered equivalent—even the fraction  $\frac{1}{2}$  was looked upon as having 2 for its *mokhraj*. We do the same thing, though we forget we do so, every time we write or think of  $\frac{1}{2}$ —which, by the way, is a very different concept from 0.5. When we speak of  $\frac{1}{2}$ , we mean that something, that "fraction," which has the same relation to 1 that 1 has to [our *mokhraj*] 2. As Rodet puts it, "il est bien certain qu'Aahmesu ne 'réduisit ses fractions à un dénominateur commun,' mais que, comme on l'a fait après lui pendant vingt-six et trente siècles encore, il choisissait un nombre, bloc extractif, fonds commun ou comme on voudra l'appeler, d'où il puisse tirer toutes ces fractions, soit comme ses successeurs à l'état d'entiers, soit comme il s'en contentait à l'état d'à peu près entiers, mais, dans ce cas, avec une fraction d'expression simple; et c'est sur les substituts ainsi obtenus pour ses fractions qu'il opérait." If our method has any advantage it is merely one of arithmetical technique; the older arithmetician saw as deep, if not deeper, into the heart of the problem.

It seems to me that we may help ourselves to understand the Egyptian way of dealing with fractions if we take a hint from Herodotus, and remember that the Egyptian did his counting with *pebbles*. I can imagine him pondering over a handful of pebbles, and trying to divide it into aliquot parts; then, if necessary, taking more and more similar handfuls, until he got at last a suitable and satisfactory *mokhraj*.

D'ARCY W. THOMPSON.

(To be continued.)

<sup>3</sup> Cf. Heath's "A History of Greek Mathematics," vol. 2, p. 543

## Nature and Mind.

- (1) *Prolegomena to an Idealist Theory of Knowledge*. By Prof. Norman Kemp Smith. Pp. xiii + 240 (London: Macmillan and Co., Ltd., 1924) 10s. 6d net.
- (2) *Modern Theories of the Unconscious*. By Dr. W. L. Northridge. Pp. xv + 194. (London: Kegan Paul and Co., Ltd., 1924.) 8s. 6d. net.
- (3) *The Nature of Laughter*. By J. C. Gregory. (International Library of Psychology, Philosophy and Scientific Method.) Pp. v + 241. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1924.) 10s. 6d. net.
- (4) *The Beautiful*. By Henry Rutgers Marshall. Pp. x + 328. (London: Macmillan and Co., Ltd., 1924.) 15s. net.
- (5) *The Philosophy of Music*. By Dr. William Pole. Sixth edition, with an Introduction by Edward J. Dent, and a Supplementary Essay by Dr. Hamilton Hartridge. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xxiv + 342. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1924.) 10s. 6d. net.

THE common presumption of the mutual indifference of philosophy and science has never been true of the masters. Every great creative mind in philosophy has been responsive to the scientific situation and method of his day, and most of those who have formulated the decisive hypotheses of the various sciences have recognised the scientific importance of those inquiries into the presuppositions of knowledge or into the most general features of reality, which are the proper business of philosophy. But though the greater movements of both disciplines have thus influenced each other, it is no doubt true—and part of the price we pay for our instrument of specialised investigation—that the detailed working out of these dominant conceptions in each field has proceeded with relatively little reference to the other; and that from time to time there has been evident a failure of adjustment and harmony.

One of the significant elements in our contemporary position is that both sides seem to be increasingly conscious of the loss involved in such a failure, so that there is a well-marked effort to co-ordinate the results of both lines of inquiry. Of this tendency, so far as it touches philosophy, Prof. Kemp Smith's important essay in the theory of knowledge (1) is the latest and a most instructive example: and although it is a technical and even a difficult book, it may well be recommended to the attention of those who wish to see how philosophical discussion is affected by and shapes towards current scientific thought. Prof. Kemp Smith's problem,

of course, is primarily philosophical, and its orientation to scientific interests is incidental. He is concerned with the relation of the long-continuing idealist tradition to the resurgent and perhaps now dominant mode of philosophical realism. But this realism is itself a product of the impact of science on philosophy, or (more accurately) it represents in philosophy, now as always, the preoccupation with the distinctively scientific problem and point of view. In dealing with it Prof. Kemp Smith avails himself, though as buttresses rather than as foundations of his conclusions, both of Dr. Whitehead's philosophy of Nature, and of the physiological researches of Dr. Head and Sir C. S. Sherrington, while one important section of his argument is governed by certain general biological considerations.

The title of the book is elliptical. It offers not what would ordinarily be called an idealist theory of knowledge, but a theory of knowledge thoroughly realist in temper as a prolegomenon to an idealist metaphysic. Of this latter, nothing is here given except brief indications at the beginning and end of the book. But these are sufficient to show the relation which the writer intends his theory to bear to idealist doctrine. What he aims at doing is, in a word, to reform and strengthen its main defences which (he thinks) have been badly shattered by realist criticism.

The crucial issue for idealism, Prof. Kemp Smith holds, is as to the status in reality of the great human interests of knowledge, morality, art and religion. Now idealism has been wont to rest the defence of these interests upon a particular view of the relation of subject and object in knowledge, which it has reached by an analysis of the implications of the intelligibility of the world. It has supposed that such an analysis would show that the world of our experience depends for certain of its ultimate features on the constitutive character of its relation to mind: and that if reality thus accepts the lead of mind in the process of knowledge, the way is open to us to hold that it will do so also in the further constructions which mind puts upon it.

Prof. Kemp Smith does not wholly dissent from this approach. It is essential to his view to hold to the correlation of mind and Nature, in virtue of which the categories or *a priori* principles of explanation employed by the mind are interpretations of the real world. He holds, too, that it is by these categories that we are led to the further ideal determinations of our higher spiritual interests. But he clearly believes that much of the familiar statement of this argument is vitiated by an assumption that this correlation implies that mind somehow dictates to Nature, so that the idealist version of the *a priori* is entangled in the embarrassment of subjectivism. Against all theories of this sort he

accepts as valid the realist principle that if knowledge is to be genuine, it must be knowledge of an independent reality, which the mind in knowing neither makes nor alters. His agreement with that view is expressed in a full critical statement first of the attractiveness and then of the defect of the whole doctrine of "representative perception."

Prof. Kemp Smith seeks, therefore, to free idealism from this subjectivist implication. The escape lies in taking Nature as an authentically independent system; and from that viewpoint finding a new and thoroughly objective deduction of the categories. If Nature is such a system, space and time, its fundamental features, must be independently real; and it is as such, Prof. Kemp Smith holds, that they do, in fact, disclose themselves to the mind. They are not forms imposed by the mind, nor are they constructions or elaborations of sense data of another sort. But they reveal themselves not indeed through but in terms of sense experiences or "sensa" of various kinds: and the apparent dependence of these sensa (as in the secondary qualities) on different apprehending minds raises a question of their objective character. Prof. Kemp Smith's solution is that the sensa though "private," *i.e.* occurring in connexion with particular physical and physiological conditions at particular points in space and time, are not "subjective" but are capable of statement as events in an objective order, so that their interpretation as such may be taken to yield knowledge of that order. Finally the categories, through the fundamental categories of totality and necessitation, are involved in our intuition of space and time. They, too, therefore, are directly apprehended as constituent of Nature. In themselves they are formal and problematic, predetermining nothing, but dependent for their concrete significance on our experience of the objective order.

Here, then, so to say, the defences of idealism are reversed. If the metaphor of prescription is in order at all, it is Nature which prescribes to mind, not mind to Nature. But whatever the priority, at least mind remains integral to Nature and our dealings with reality are face to face. What measure of idealism may rightly be based upon a so little pretentious theory of mind is not yet declared. It is possible that Prof. Kemp Smith has conceded to the realist criticism more than is strictly compatible with an idealist view: but at all events a highly interesting and even exciting sequel is promised.

The tendency exhibited in Prof. Kemp Smith's book to "democratise" the mind, as Prof. Alexander calls it, to put the mind in its proper place in relation to the rest of the natural order, has been operative in other regions than those of epistemology and metaphysics. The modern analytic movement in psychology

associated with the name of Freud has been working to the same end. Its purpose is to interpret mind by its own natural history, and to show its dependence upon energies and functions which, if not simply bodily, are at least closely connected with the body.

The main tenet of the recent teaching on this topic centres on the larger meaning and greater significance attached to the conception of the unconscious. Dr. Northridge in his book (2) rightly singles out as the cardinal point in Freud's theory the distinction between the "preconscious" and the "unconscious." The older view of the unconscious regarded it as covering only those states of mind which were temporarily out of the field of consciousness, but could be revived, sometimes not without difficulty, but without special artificial preparation. This Freud designates the pre-conscious, reserving the name unconscious for those states which, because of their incompatibility with conscious interests, can enter consciousness only in a disguised and symbolical form, but which, though thus largely excluded or repressed, profoundly affect the tenor and quality of conscious life. Dr. Northridge explains the genesis of this conception through a discussion of Hartmann, Schopenhauer, Myers's theory (or theories) of the subliminal self, and those more recent students of the phenomena of dissociation and multiple personality like Janet, Sidis and Morton Prince. Chiefly, of course, he is concerned with Freud, and with the evidence on which Freud bases his revolutionary theory. With Freud's work, Dr. Northridge compares that of Jung and the late Dr. Rivers; and indicates the points on which he regards their later and broader treatment as more satisfactory. Dr. Northridge's book is almost wholly expository; he clearly takes Freud's work to be decisive on the general question as to the validity and fruitfulness of the analytical method. But within the limits which he sets himself it is a careful, competent and discriminating survey of the field, with its emphasis and contrasts well taken and justly marked.

On Freud's view, one of the main supports for the hypothesis of the unconscious is furnished by the study of wit. Mr. Gregory's learned discourse on laughter (3), however, is not unduly oppressed by Freudian theory. Freud, like Bergson, he believes to have thrown light on certain forms of laughter; but neither theory is universally applicable. Mr. Gregory works on a larger canvas. He ranges the whole field of recorded human laughter, from Homer to Charles Chaplin; and though the central idea which he derives from his survey is not novel, he illumines it with many fresh and suggestive analyses. His method is cautiously empirical. Laughter is endlessly varied in its occasions, forms and associated emotions. Still, if we follow the clue given

by the physical process of laughter, it is possible to recognise in all forms of it one fundamental mechanical pattern, which may be described by the word "relief." Laughter occurs whenever an agent having prepared himself for action of some kind finds that action is unnecessary; it is the bodily concomitant of release from some position of tension. The variety of the forms of laughter is traceable to the very different ways in which this experience of relief can occur, from simple physical sensations like tickling to the most complex psychical situations. But certain main types of laughter can be distinguished; and, Mr. Gregory holds, it is possible to show how these types emerge and change with the progress of civilisation. The first type is ungracious laughter, laughter touched with contempt or animus, as against physical deformity or over a beaten enemy. But its later forms are more refined and kindly—as in the genial laughter of sympathy which is the source of humour, or in that distinctively intellectual form of it which is expressed in the comic spirit.

Mr. Marshall's treatise on æsthetics (4) takes the reader into a wholly different atmosphere. It is, in its way, an old-fashioned book, not over much concerned (except for Croce) with the most modern theories, but building a lucid and persuasive if not wholly convincing argument with a delicate and careful craftsmanship that is worthy of its theme. Mr. Marshall seeks first to develop his theory and definition of the beautiful. The conditions of beauty, he holds, cannot be stated in purely objective terms. An object, of course, is necessary, to provide the external stimulus; but since very different æsthetic judgments are passed on the same objective factors, there is clearly involved a subjective element as well. Where then is beauty to be found?—in sensation, or in perception or in the intellectual apprehension of certain formal relations subsisting between the parts of a perceived object? Or is its source rather in imagination or in emotion or in feeling, or perhaps even in religious and moral ideas? Each of these views, Mr. Marshall holds, might suffice to define some of our experiences of beauty, but none of them applies to all. Mr. Marshall's own account is that beauty is "relatively stable or real pleasure." "We call an object beautiful which seems always to yield pleasure in impression or contemplative revival." Similarly, ugliness is relatively stable disagreeableness.

One may perhaps suspect that if preceding theories have erred by defect, Mr. Marshall's zeal for an all-inclusive account leads him to err by excess. No doubt all experiences of beauty yield pleasure of the kind here described. But it does not appear that, as the theory requires, this proposition is convertible simply. There seem to be fields of relatively stable pleasures to which

the term beauty cannot be strictly applied. The enjoyment of a strenuous game may be more stable, both in act and in recollection, than that of the loveliness of a fleeting sunset; but it is not therefore more beautiful, or even beautiful at all. Mr. Marshall is not unmindful of this difficulty. But his escape from it, mainly by an appeal to the revivals of meaning associated with particular pleasure experiences, scarcely goes to the heart of the matter.

The remainder of the book gives the application of the theory to some of the major questions of æsthetic philosophy; and a short historical review of the relation of various æsthetic theories to the meta-physical systems in connexion with which they have been developed.

"The Philosophy of Music" (5) is the sixth edition of a well-known book by Dr. William Pole. It is introduced and supplemented by short essays from Mr. E. J. Dent and Dr. Hamilton Hartridge. The book gives no hint to this later generation of the rather unusual combination of interests in its author, though the reader might guess from the treatment that Pole was much concerned with physics and structures. If further issues are called for, a biographical note would not be out of place. H. J. W. HETHERINGTON.

### The Energetics of the Living Cell.

*Chemical Dynamics of Life Phenomena.* By Prof. Otto Meyerhof. (Monographs on Experimental Biology.) Pp. 110. (Philadelphia and London: J. B. Lippincott Co., 1924.) 12s. 6d. net.

THE scope of this fascinating addition to the series of American Monographs on Experimental Biology is restricted to the two fundamental and interconnected problems of cell respiration and the energetics of cell processes. The book is founded upon a series of lectures delivered in Cambridge and New York in 1922-23 and presents a connected account of the author's well-known work, considered in close connexion with that of other investigators, both in Germany and elsewhere.

These researches have revealed another example of the extraordinary complexity of the physical and chemical mechanism which has been evolved for the realisation of a fundamental physiological requirement, in this case the provision by the organism of energy available for the performance of work, either chemical or mechanical. Two methods for the accomplishment of this are found to exist, both subject, as are all processes in the living organism, to the limiting condition of a low and often an almost constant temperature. These are the aerobic system, in which the energy is derived from the oxidation of food materials, and the

anaerobic, in which it comes from their fermentation. The comparative study of these two processes—respiration and fermentation—forms the subject of one of the most interesting chapters of the book, to which the previous sections on the mechanism of cell respiration and autoxidations in the cell serve as an introduction.

The author traces in detail the intimate relations which have been established between these two apparently independent but in reality closely allied processes, and concludes on a justifiably triumphant note: "It may indeed be considered a success of general physiology and its mode of experimenting, that the chemical dynamics of a highly differentiated organ like the muscle could be partly revealed by the study of the alcoholic fermentation of yeast."

The ensuing chapter, on the transformation of energy in muscle, carries the tale a stage further, and shows how far the tangled skein of physical and chemical changes involved in the contraction and relaxation of muscle has been unravelled. To appreciate the boldness of idea and skill in technique which have gone to the solution of this problem, this work must be studied in detail. To summarise very briefly and imperfectly, it may be said that during the contraction of a muscle, glycogen is rapidly converted into lactic acid, energy being thus rendered available by the chemical change and by the reaction of the resulting lactic acid with the alkali protein of the cell, too great a change of hydrogen ion concentration being at the same time avoided. So far the change is anaerobic and independent of the presence of oxygen. Relaxation is accompanied by the absorption of oxygen and the complete oxidation of a varying fraction, a quarter to a sixth, of the lactic acid, the remainder of the lactic acid being at the same time reconstituted into glycogen and the alkali protein of the cell restored to its original condition. Truly a remarkable device.

The concluding chapter is more general and speculative in its character, and deals with the difficult question of the constant exchange of energy which goes on in cells which perform no external work. No complete answer to this question has been obtained, but its investigation, particularly with respect to the metabolism of bacteria and algæ, has led to many important results which are here chronicled. One interesting point alone can be picked out for reference. The author has shown by direct experiment—poisoning a mass of respiring avian blood corpuscles in a calorimeter—that the old idea that living protoplasm has a higher energy content than dead is incorrect. No evolution of energy occurs at the moment of death, and the mysterious difference between living and dead matter cannot be explained on energetic grounds.

This short work must be regarded as a true romance of science, and to the sufficiently prepared reader its pages present a theme of the most enthralling interest. A pleasant feature of the book is the ungrudging recognition of the contributions of other workers to a subject which has aroused widespread interest and has been approached from many different directions.

ARTHUR HARDEN.

### Our Bookshelf.

*The Nature of Life.* By Prof. W. J. V. Osterhout. (Brown University: The Colver Lectures, 1922.) Pp. vii+117. (New York: Henry Holt and Co., 1924.) 1.50 dollars.

A MOST pleasantly written book that discusses such questions as the origin, criteria and control of life in a manner making the story of what the biologist has done and is doing in that particular field readily intelligible to the educated lay reader. The United States is to be envied in having endowments permitting public lectures of this quality to be published in book form.

The question of the origin of life is discussed and, as is inevitable just yet, is not answered. This is followed by a discussion as to the criteria by which the living is to be distinguished from the dead. Growth is not a criterion, for there can be life without growth and growth without life. There can be life without reproduction; in individual cells, such as nerve cells, or organisms, such as the resting seed, there is no reproduction, no suggestion of cell-division, yet life may go on for many years. Motion is not one of the essential characteristics of living matter. There is no logical necessity for regarding the simplest cases of irritability as essentially different from certain reactions found in non-living systems. Constructive metabolism may cease, yet life may go on for many years; but the cessation of destructive metabolism marks the end of life. In the case of the resting seed, so long as it is alive it produces carbon-dioxide: when this ceases it is dead. Life as manifested in the simplest organisms is a physico-chemical process in which destructive metabolism plays a fundamental rôle. As soon as a cell dies its power of selective absorption ceases. Certain dyes will not enter a living cell; others will do so and become stored within, reaching a higher concentration than outside. The process obeys a definite mathematical law. This storage does not occur in dead cells to so great an extent. Another method is to send an electric current through the cell; by measuring the amount of the current the progress of death can be followed with the same exactitude as that of a chemical reaction. Death is an orderly process following a definite law that can be expressed mathematically. In order to control life it is first necessary to control mutation, and before this can be done the physico-chemical factors on which mutant characters are based must be completely analysed. With the control of mutation will come the power to create new species.

*The Internal Secretions: for the use of Students and Physicians.* By Prof. Dr. Arthur Weil. Authorised translation of the third German edition by Dr. Jacob Gutman. Pp. xviii+287. (London: G. Allen and Unwin, Ltd., 1924.) 18s. net.

THE author's method of presentation of his subject is one much to be recommended. Instead of dealing with each endocrine organ separately, he has chosen as subjects all the main physiological functions and describes the way in which each function is controlled by the endocrine glands operating either singly or in co-ordination.

Medical students and practitioners, for whom the book is intended, will certainly find in it much of interest and of value. Internal secretion is defined, the embryology and histology of the endocrine glands discussed, and there follow chapters on the physiology of the blood, circulation, respiration, metabolism, growth, reproduction, the sexual impulse, the mind, the chemistry of the endocrines; methods of testing for internal secretions; the inter-relationship of the endocrine glands; internal secretion and the nervous system. There is no bibliography, but the reader is referred to works of Biedl, Lipschütz, and others.

We agree with the translator that this book will be useful to students and general practitioners, and that medical specialists in other subjects will find in it sections dealing with the relation of endocrinology and their own special branches. This comprehensive elementary treatment is well suited to beginners, notwithstanding the fact that it contains within a small compass an immense amount of information. The book was not written for the endocrinologist, but by an endocrinologist for the German medical profession, and that which may be incomplete for the specialist may be more than enough for the general practitioner.

*An Introduction to the Study of Southwestern Archaeology: with a Preliminary Account of the Excavations at Pecos.* By A. V. Kidder. (Published for the Department of Archaeology, Phillips Academy, Andover, Massachusetts.) Pp. vii+151+50 plates. (New Haven: Yale University Press; London: Oxford University Press, 1924.) 20s. net.

FOR some years past American archaeologists have devoted great attention to the south-western States, particularly New Mexico, and at the present moment excavations are being carried out on several sites. Of these Pecos in San Miguel County, New Mexico, is one of the most important, not only on account of its size, but also because of the length of time over which it was occupied by the Indian. There is a recorded occupation of practically three centuries, from 1540 until 1838, when it was abandoned, while the abundance of pottery of archaic type scattered among the mounds shows that it had been occupied for a long period before the coming of the Spaniards in the former year.

Although the account given in the second section of this volume is only a preliminary report dealing with the work in 1915 and 1916 and from 1920 onward, and it will be many years before the work is complete, it is already abundantly clear that the site is one of great importance and will without doubt throw much light upon the history and relative chronology of the development of culture in the south-western area. In

the remaining three sections of the book, Mr. Kidder deals respectively with the history of Pecos, the results obtained from excavation of the other sites of the south-west which have been explored, and in conclusion summarises these results in a general sketch of the rise and development of south-western culture. As a whole the book is a valuable contribution to the study of American archaeology which will prove of great assistance to those who wish to understand the general trend of current research in this part of the States.

*Handbook to the Technical and Art Schools and Colleges of the United Kingdom* Compiled from Official Information. With an Index to Courses of Instruction. Second edition, revised and enlarged. Pp. iv+170. (London: Scott, Greenwood and Son, 1925.) 6s. net.

As a reference book to the technical schools and colleges of the British Isles, the volume before us will no doubt serve a useful purpose. It is divided into five sections, dealing respectively with London, England (provinces), Scotland, Wales, and Ireland, the last section being subdivided into two sections covering Northern Ireland and the Irish Free State. In the London group the schools are arranged alphabetically, whereas in the remaining sections they are under towns, which again appear in alphabetical order. Under each entry is given essential information about the school, together with an indication of the courses of study, day and evening, which are available. There is a full index to the courses of instruction, so that it is possible to see quickly where any particular subject is studied.

*Stories of the Birds from Myth and Fable.* By M. C. Carey. Pp. 192+8 plates. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1924.) 5s. net.

THE author of this book has culled from many standard works on the folklore of peoples such myths, legends and fairy tales as relate to birds, and has recast them in simple language suitable for children. The result is a series of quite charming tales, delightfully told, which, in the pleasant guise of fable, include a considerable measure of true and salient facts about the form, habits and natural history of birds. Primitive man was always a close observer of natural things, and the myths which centre round natural phenomena are merely his attempts to find reasons for things which he could not otherwise explain.

Children will be delighted with this book. Those who are students of birds will be no less interested in the ingenious and fanciful explanation of avian habits and structure put forward by early man.

*Skill in Work and Play.* By Prof. T. H. Pear. Pp. 107. (London: Methuen and Co., Ltd., 1924.) 4s. net.

THIS book is a study of the way in which muscular skill is acquired. It is eminently popular in exposition; but behind its somewhat racy style lies the weight of facts that have been investigated in carefully planned research. Prof. Pear applies the facts, originally brought to light in connexion with problems of industrial psychology, not only to the acquisition of dexterity in such operations as typewriting and metal polishing, but also to those of athletic skill as exemplified in cricket, skating, and similar games and sports.

## Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

### The Taungs Skull.

I OWE to the kindness of my friend Dr. Broom a preliminary sketch of a sagittal section through this remarkable skull. Prof. Dart, though he is himself earnestly engaged in the description of the skull, has generously afforded Dr. Broom full access to it with permission to publish any observations he may make.

As the preliminary section is extremely interesting and completely confirms, so far as it goes, the statements of Prof. Dart, I have been tempted to compare it with similar sections through the skulls of young chimpanzees preserved in our University Museum, which my friend Prof. Goodrich has kindly put at my disposition.

In Fig. 1 the profile of the Taungs skull (continuous

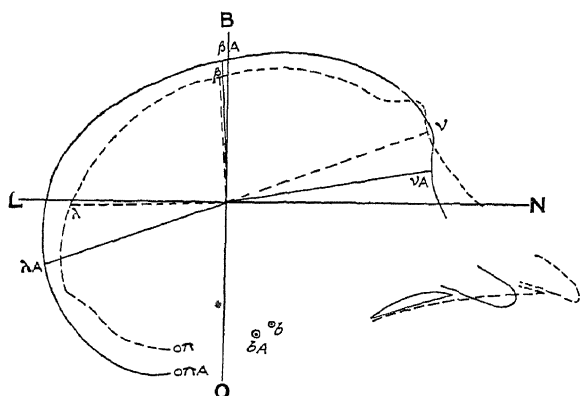


FIG. 1.—Superposed profiles of Taungs skull (continuous lines) and of skull of young chimpanzee, one true molar erupted (broken lines). OB, occipito-bregmatic axis; LN, lambda-nasion axis,  $\nu$ , nasion,  $\beta$ , bregma;  $\lambda$ , lambda. Points on the Australopithecus profile are distinguished by the addition of the letter A. ( $\times$  about  $\frac{1}{2}$ ; the greatest length of the Taungs skull is 127 mm.)

lines) and that of a young chimpanzee (broken lines) are superposed on a common morphological centre and the bregma-occipital axis. The greater size of the Taungs skull is sufficiently obvious, and equally so the complete absence of a frontal torus, while this feature is already well developed in the chimpanzee. The bregmas are nearly coincident but the lambdas are far apart, and the parietal arc of the Taungs skull ( $108^\circ$ ) is therefore considerably larger ( $19^\circ$ ) than that of the chimpanzee ( $89^\circ$ ). This marks an approach towards the human side. The comparative shortness of the face and the diminished prognathism of the Taungs skull are also well displayed.

I ought to mention that the basion and opisthion are not preserved in the Taungs skull, but their probable position has been indicated by Dr. Broom with a possible error of 2 mm. for the opisthion and 4 mm. for the basion.

In Fig. 2 the profile of the Taungs skull is compared with that of a chimpanzee already furnished with a complete dentition. It will be seen that the Taungs skull, although in an earlier stage of development, has attained to a profile of about the same area as that of the adult chimpanzee, which in this specimen has a cranial capacity of 440 c.c.

In Fig. 3 full sagittal sections are given in place of

profiles, and that of the chimpanzee has not been obtained from the one shown in Fig. 2 but from another adult specimen. No stress can be laid on the comparison of the two sections, since they represent different stages of growth. In a young chim-

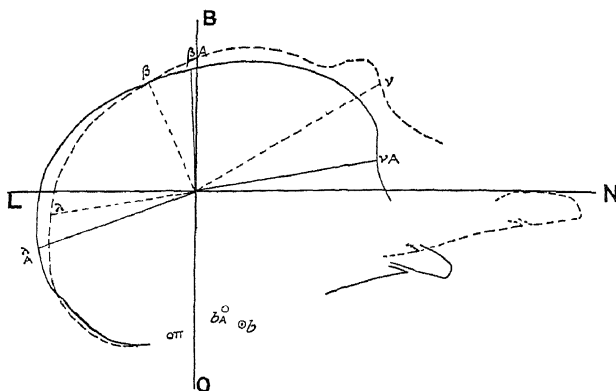


FIG. 2.—Profiles of adult chimpanzee and Taungs skulls superposed ( $\times$  about  $\frac{1}{2}$ )

panzee, with only the first molar erupted, the anterior extremity of the brain may extend much farther downwards than in the adult.

Attention, however, may be directed to a peculiarly interesting feature of the Taungs skull as displayed in this figure. It will be seen that the nasion is situated, as in man, close to the anterior limit of the brain. In the higher apes this relation is lost at an early stage; the nasion rises progressively with age, and so does the frontal bone, which seems to turn upon the bregma as upon a hinge. This is well illustrated by the profiles of chimpanzees in different stages of growth shown in Fig. 4.

I should have liked to make a comparison with the skulls of young gorillas, but unfortunately our collection does not contain any skulls in which the first true molar has alone been cut. We have adult skulls and some with the deciduous dentition only. Of the latter there is, however, one in which the first molar, though still occluded, is not far from eruption,

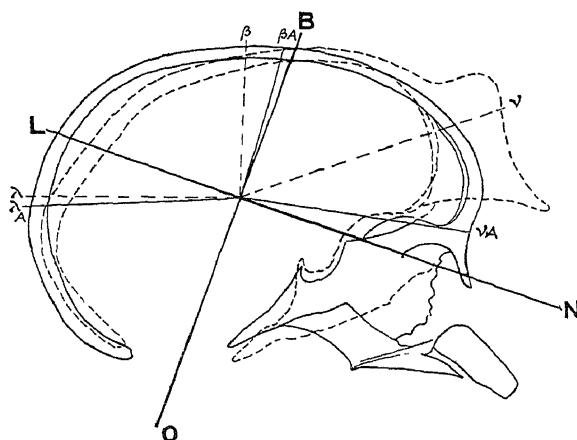


FIG. 3.—Sagittal sections of Taungs skull and skull of adult chimpanzee superposed ( $\times$  about  $\frac{1}{2}$ )

and this skull closely resembles in profile that of the chimpanzee of Fig. 1. The areas of the profiles are almost identical, and the frontal torus of the gorilla is only faintly expressed.

There is nothing in these observations which would lead one to conclude that the adult Australopithecus

possessed a much larger brain than any existing ape. The gorilla, as shown by Selenka, has a brain of 400 c.c. in the young stage, when it possesses only the deciduous teeth, and it attains to a maximum of 590 c.c. in the adult. This, however, is a matter of only secondary importance. It is abundantly clear

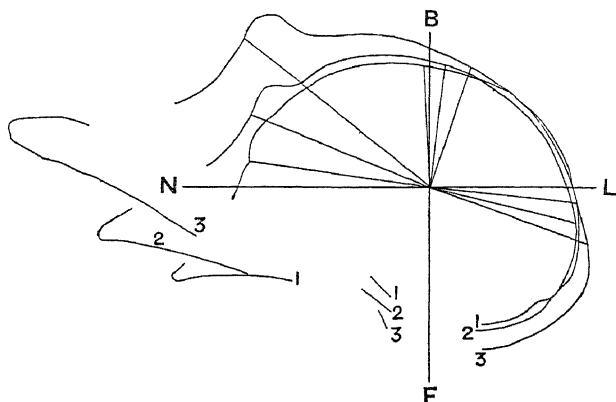


Fig. 4—Profiles of the chimpanzee skull in different stages of growth.

that in a number of significant morphological characters, such as complete absence of the frontal torus, position of the nasion, greater magnitude of the parietal arc, reduced prognathism and shortening of the maxillary region, *Australopithecus* makes a nearer approach to the Hominidæ than any existing anthropoid ape.

W. J. SOLLAS

University College, Oxford.

### The Discovery of Benzene.

IN view of the projected celebration of the centenary of Faraday's discovery of benzene in 1825, it is important that any doubt concerning his priority should be dispelled. The standard work on coal-tar, Lunge's "Coal Tar and Ammonia," states on p. 223, vol. 1 of the fifth edition (1916): "It is usually stated that benzene was discovered in 1825, by Faraday, in the liquid separating from condensed oil-gas, but Schelenz (*Z. angew. Chem.*, 1908, p. 2577) has shown that the compound which we now term 'benzol,' or more recently 'benzene,' had been discovered in coal-tar forty years before Faraday in the year 1825 reported 'On new compounds of carbon and hydrogen. . . .'" Lunge then quotes from Schelenz three passages, culled from the chemical literature of the period 1740-1784, which in the opinion of both prove that benzene "was undoubtedly known forty years earlier" (although elsewhere in his article Schelenz refers to "Faraday's discovery, of which England can indeed be proud"). The citations from the eighteenth century are from German versions of Macquer's "Dictionary of Chemistry" (Leipzig, 1783), Demady's "Laborant" (Leipzig, 1784), and Caspar Neumann's "Prælectiones Chemicæ" (Schneeberg, 1740).

These works not being available, reference was made to similar English versions. In volume 1 of the English translation of the first French edition of Macquer's work (1766) we read (p. 166, footnote): "Fossil coal by distillation yields 1. a phlegm or water; 2. a very acid liquor; 3. a thin oil like naphtha; 4. a thicker oil, resembling petroleum, which falls to the bottom of the former, and which rises with a violent fire; 5. an acid concrete salt; 6. an inflammable earth remains in the retort." In volume 1 (p. 385) of "The Chemical Works of Caspar Neumann, M.D.," edited by William Lewis (second edition, London, 1773), the author states that 48 ounces of

the best sort of pit-coal from Halle heated in a glass retort with a fire gradually increased, yielded 2 ounces 7 drachms of a thin fluid oil, and 1 drachm of a thick, tenacious, ponderous, pitchy oil, which stuck in the neck of the retort: the residuum weighed 40 ounces 7 drachms. . . . That which distilled at first was light, and swam on water, the succeeding parcels proved more and more gross and ponderous, and at last sunk." The coarse stony pit-coal of Halle yielded no oil.

These quotations will suffice to show that the chemists of that period knew how to obtain by destructive distillation of certain coals a number of loosely-defined mixtures as fractional distillates, but they afford no evidence whatever that the light-oil or any other fraction was known to contain a definite, homogeneous chemical individual, which we know as benzene. Nevertheless, Schelenz states that Neumann certainly had benzene before him! Undoubtedly he had, but only as one constituent of a very impure mixture; and the preparation of a mixture which years later is proved to contain a hitherto unknown chemical compound does not constitute a discovery of that compound. Has Liebig ever been credited with the discovery of bromine? He actually saw it years before Balard "discovered" it. It is surprising that the statement in "Lunge" should have remained so long unchallenged, and it is fitting that at this time it should be given an unqualified and definitive denial.

It might be contended that Faraday's title to the honour of discovering benzene is rendered doubtful by the fact that he did not obtain it in a pure state. In his paper to the Royal Society (*Phil. Trans.*, 1825, p. 440) Faraday admitted that his "bicareburet of hydrogen" was impure ( $C = 11.576$ ,  $H = 1$ , compared with  $C = 12$ ,  $H = 1$ , required by theory), probably because it contained another hydrocarbon containing 8.25 parts of carbon to 1 of hydrogen. In this connexion it is interesting to compare Faraday's values of some of the physical constants of benzene with the values accepted to-day (Faraday's values are given first): sp. grav. 0.85 (at  $15.5^{\circ}C.$ ): 0.8850 (at  $15^{\circ}C.$ ); melting point  $5.5^{\circ}C.$ :  $5.483^{\circ}C.$ ; boiling-point  $85.5^{\circ}C.$ :  $80.2^{\circ}C.$ ; density of vapour ( $H = 1$ ) nearly 40:39. Allowing for different degrees of accuracy of the measuring instruments in use a hundred years ago and of those now available, the conclusion seems to be justified that, without any doubt, Faraday was the first to isolate benzene in a substantially pure state; and there has never been any question that he was the first to investigate its physical and chemical properties.

E. H. TRIPP.

May 27

### Double Impacts by Electrons in Helium.

IN a paper on the precise measurement of the critical potentials of gases (*Proc. Roy. Soc.*, 107-291, 1925) Mr. E. G. Dymond finds that the difference between the first and second kink in the current potential curve in helium is 20.9 volts and not 20.55 volts as one would expect if the first kink corresponds to electrons which have caused the transition  $1S-2s$  (type A), and the second kink to electrons which have caused two transitions  $1S-2s$  and  $1S-2s$  (type B). In attempting an explanation he assumes that in his apparatus the second kink is due to the transition  $BB$ .

I would like to suggest in the first place that this disagreement is possibly explained when the energy lost by elastic impacts between electrons and helium atoms is taken into consideration, and in the second place that the double impacts are probably of the

type *BA* or *AA*, rather than of the type *BB* assumed by Dymond.

Taking up the latter point first, if it is assumed that at forty volts the probability of a *B* transition is greater than of an *A* transition, then I believe that the second kink is of the type *BA* and not of the type *BB* for the following reason. As the accelerating field is gradually increased in the neighbourhood of forty volts, the electrons *first* get enough energy to cause the double impact of the type *B* followed by type *A*, *before* they get enough energy to cause the double impact of type *B* followed by type *BB*. The double impact is then of the type *BA*. However, if it is assumed that at forty volts the probability of type *A* transition is greater than for type *B*, then the double kink will correspond to type *AA*. That is, the second impact of the first double kink will always be of type *A*. Of course as the field is further increased the type *BB* would, in the ideal case, appear as a second double kink 0.8 volt higher than the double kink of type *BA*. In this ideal case (no energy losses by elastic impacts and maximum probability of impact at the critical potential), the difference between the double kink and the single one would for type *AA* be 19.77 volts, for type *BA* 20.55 volts, and for type *BB* 21.33 volts, as has been assumed heretofore.

If, however, the energy losses due to *elastic impacts* are taken into account, then I arrive at the following relations for the energy spent by typical electrons which start out with the energies found by Dymond as corresponding to the first and second kinks.

For a single impact of type *A* :

$$22.2 + C = E'_A + 19.77 + R_A \quad (1)$$

For a double impact of type *BA* :

$$43.1 + C = E_B + 20.55 + E_A + 19.77 + R_A \quad (2)$$

The left-hand side of both equations represents the *total* energy of the electrons, 22.2 volts and 43.1 volts being the points on Dymond's curves where the drop in current is most pronounced. The quantity *C* is the correction due to initial velocity. *E'\_A* is the energy lost by elastic impacts which precede the inelastic one which a 22.2 volt electron makes. Similarly *E\_B* is the average energy lost in elastic impacts by a 43.1 volt electron before it makes inelastic impact of type *B*, and *E\_A* is the average energy lost by elastic collisions of the same electron *after* it has made its first inelastic impact (type *B*), and before it made its second inelastic impact (type *A*). In both cases (19.77 + *R\_A*) is the potential at which the probability of type *A* transition is a maximum.

Subtracting equation one from two it is found that

$$20.9 = 20.55 + E_B + E_A - E'_A \quad (3)$$

It is seen that the difference between the kinks is not equal to the critical potential, but that it differs from it by the quantity

$$(E_B + E_A) - E'_A = 0.35 \text{ volt.}$$

A figure so large as 0.35 volt for the difference in the energy lost by elastic impacts in the two experiments does not seem unreasonable. It can be shown from the laws of the conservation of energy and momentum that a forty-volt electron loses 0.010 volts per impact with a helium atom, while a twenty-volt electron loses only 0.005 volt per impact. Hence, since Dymond estimates that an electron makes in the neighbourhood of a total of 400 collisions in passing through his apparatus, one need not be surprised by a difference of the order of 0.35 volt in the amounts lost by elastic impacts in the two different experiments.

If the above views are correct, it means that for

a gas of small atomic weight like helium the usual method of correcting for initial velocity and contact potential, by taking the difference between kinks equal to a critical potential of the gas, is not permissible.

I am indebted to Prof. R. C. Tolman of this institute for the opportunity of discussing these matters with him.

GEORGE GLOCKLER.

(National Research Fellow in Chemistry.)

Gates Chemical Laboratory,  
California Institute of Technology,  
Pasadena, California, April 9.

I AM indebted to Mr. Glockler for his remarks on the influence of elastic collisions on the measurement of critical potentials, but I cannot agree with him that the loss of energy from this cause can with my apparatus result in a sensible error in the values of the excitation potentials of helium.

In analysing my curves Glockler has considered only the points where the rate of fall of current is at a maximum. This is not justifiable, however, as the retarding potential used between the plate and grid was 0.5 volt. This implies that the current drop at any point does not represent the number of inelastic impacts at that potential, but the number integrated backwards over a range of 0.5 volt.

If, however, we deal, as in my measurements I have done, with only the first break points, a little consideration will show that energy loss by elastic impacts can play no rôle but that of reducing the region in which an electron can effectively collide; that is to say, that it can only reduce the probability of inelastic collision, as at the critical velocity any energy loss renders the electron incapable of exciting. This means that inelastic impacts first take place in the neighbourhood of the grid and gradually spread throughout the apparatus as the voltage is raised. The reasoning, of course, applies alike to the single and double impacts.

This independence of the position of the kinks on the loss of energy by elastic impacts is a property of the type of apparatus used. Benade and Compton (*Phys. Review*, 11, p. 284, 1918) have, of course, shown that when a number of collisions can take place during acceleration of the electrons, the position of the kinks is a function of the pressure, but in the apparatus used by me the electrons are accelerated to their full velocity before making any collisions.

The reduction in the probability of effective collision for voltages immediately in the neighbourhood of the critical potential will certainly make the kinks less sharply marked, but I think that an inspection of my differential curves will show that an error of 0.1 volt is the most which can be made from this cause.

E. G. DYMOND.

Zweites Physikalisches Institut der Universität,  
Göttingen, Germany, May 8

#### Possible Effects on Marine Organisms of Oil Discharged at Sea.

THERE have recently appeared in the Press imaginary descriptions of devastations caused among larval fishes and other marine organisms by oil floating on the sea. So far as the present writer knows, these descriptions—some by influential writers—are anticipations of what might occur if oil were a moderately poisonous substance. Oil is certainly noxious, and the writer is fully in agreement with the descriptions which have been given in the Press of the disgusting conditions due to it at high-water mark along our shores and sometimes also at sea, but there is

little evidence as yet to show that the kind of oil lost or discharged at sea is even mildly poisonous. For this reason it is necessary to adopt a much more agnostic view than is at present current with regard to the effect of oil on marine organisms. The kind of oil used for fuel on ships at sea is, I am informed, entirely petroleum oil in its crude state or the residue left after the separation of its more valuable and lighter constituents; but it is unlikely that much of these oils will escape or be knowingly discharged from ships, except the heavier residues along with waste lubricating oil. Until it is known what chemical constituents this waste oil contains, it is premature to imagine that it has any serious harmful effect on marine organisms. The more poisonous coal-tar oils are apparently not used as marine fuel oils.

Experiments by Orton and Elmhirst on petroleum residues, taken from masses of this material floating on the sea, indicate—as do some chemical analyses by the Government Chemist—(see Orton, Fisheries Investigations II, 6, No. 3, pp. 134–145)—that these oils are practically non-lethal, either directly from toxic constituents, or indirectly from their physical properties. Indeed, it is doubtful if these substances are as poisonous as human urine. These samples of oil, however, are only two of a large number which require to be tested before previous contact with sea water.

The effect of a lubricating oil on marine organisms was observed by the present writer on a wreck, ss. *Rock Highland Bridge*, which sank off Falmouth Harbour and was moved inshore to the mouth of the Helford River. This wreck had not been an oil-burning vessel, but oil was escaping in small globules from the engine-room and had covered the starboard side of the vessel amidship with a coat of congealed oil for about ten yards. This oil was smeared over a quantity of young mussels and limpets (*Patella*), which were found to be clean and healthy and approaching sexual maturity. A number of fishes—pollack, gobies and smelts—were swimming close to the rising oil and below the oil film, and also close to the oily side of the vessel was found a shoal of copepods, mainly *Calanus finmarchicus*, which is notoriously an inhabitant and apparently a lover of good clean water. The mussels mentioned above were stunted in growth, it is true, but dwarfing in situations near high-water mark—as these were—is well known (see Orton, Jour. Marine Biol. Assoc., vol. 10, 1914, p. 319). Thus from actual experiments and observations on certain oils there is ground for taking the view that—apart from actual contact with oil, and not always even then—oils such as are lost at sea are not very dangerous to marine life.

It is an obvious and deplorable fact that birds which become fouled with oil have died and are still dying off in consequence in considerable numbers, but there is little ground for statements that any organisms on the shore are being killed off in wholesale fashion. It is indeed rare to find objects smeared with oil on the shore anywhere below about high-water neaps. A thick oil may become entangled in a branching wet surface, such as some seaweeds offer, but not easily.

Even water-gas tar, which is known to contain poisonous constituents, was found by Mitchell (Bull. U.S. Bureau of Fisheries, 32, p. 199, 1912) to be harmless to oysters in running water, though the tar had previously been injected into the mantle-cavity of the bivalve. The explanation of this is probably simply that the tar was immediately or soon shot out of the precincts of the shell and was unable to adhere in any significant amount to any of the soft parts, which are normally wet and covered with a film of mucus which is easily sloughed.

If one supposed that oil contained a fair amount of soluble poisonous substances, the fact that oil forms a film on the surface of the water would cause the toxic substance to be exposed to immediate dilution which would soon become great in any tideway. If, on the other hand, fish eggs, for example plaice eggs, were floating near the surface under a layer of oil in a rubbly sea, it seems possible that globules of oil may come in contact with the eggs or larvæ, but if they did, would they envelop them and kill them? If potential fishes were killed in this way, what area of the ocean would be affected by the oil and to what depth in these areas would the oil affect living organisms? All these questions are relevant, and no doubt answers to some of them could be obtained by simple laboratory experiments.

One further fact of interest was observed in my own experiment with a petroleum residue taken from the sea. After about six weeks contact with sea-water, the oil hardened into a scum and began to sink, but before it sank crowds of a small white polychæte (*Ophryotrocha*) were found eating the scum of oil—probably for the sake of the bacteria feeding on the oil in turn. *Ophryotrocha* is a notorious scavenger, and is frequently taken in thousands from an old boot dredged up from the sea. Some oils, therefore, add to the available food-material in the sea, and it is clear that further information is required before we can actually gauge the effect of oil upon the sea on the life below the surface.

J. H. ORTON.  
The Laboratory, The Hoe,  
Plymouth, May 19.

#### Salps and the Herring Fishery.

RECENTLY the chairman and one of the scientific staff of the Fishery Board for Scotland, after two seasons (1920 and 1921) in which the shoals of herring had been scarce in their usual haunts, published communications in which it was suggested, though not distinctly asserted, that certain Atlantic currents had filled the usual grounds with hordes of salps—to the detriment of the herring. By and by it was pointed out by those familiar with salps and their life-history that such a suggestion was untenable. Now, we have an article (*Scotsman*, May 5) in which Mr. Arthur Samuel, M.P., Minister for Overseas Trade, again revives the subject, and by using the term “jelly-fish” for the salps has not added to the simplicity of the matter; for salps are in no way connected with jelly-fishes in structure, mode of feeding, development, or life-history.

This confusion is seen in the letter Mr. Samuel gives from the American Fish Commissioner, who descants on the voracity of the jelly-fishes, so long ago humorously told by Edward Forbes, which leads them to engulf forms much higher in the animal scale than themselves, e.g. young fishes. So much is this the case that if the tow-nets and collecting vessels are not quickly attended to, the small jelly-fishes and ctenophores (*Thaumantias* and *Pleurobrachia*) levy a heavy toll on the young fishes.

But salps do not feed like jelly-fishes and their stomachs are ill-fitted for such a diet. The American author, indeed, suggests that the currents which conveyed the salps to these regions probably caused the migration of the herrings, though this is still in want of proof. He adds a word in favour of the jelly-fishes in so far as certain young fishes shelter under their discs, and he might have supplemented this by the fact that the Japanese dry and eat certain forms.

These facts, however, are altogether beside the question of the effects of hordes of salps on the herring

fishery; and Mr. Samuel concludes that he is "not certain that salps were the direct cause of the ill effects of our herring fishery," though he goes on to say that salps may consume the minute organisms on which the herring feed, a statement also requiring proof. He supposes that the salps float on the surface of the water only—which they certainly do in fine, calm weather with a smooth sea, their contractions breaking the surface like tremors on molten glass. But the moment a storm of wind and rain sets in they disappear from the surface, and they may be beached in long lines six or more inches deep on the tidal margin like masses of boiled sago. In ordinary calm weather, again, one might look from a boat into the deep water of the Hebridean lochs and observe at all depths chains of salps and solitary individuals moving slowly therein as well as at the surface. Indeed, when the climax of the invasion was reached the sea in Lochmaddy for long distances resembled boiled sago, and with every stroke of the oars the salps rose from the water and rolled like glassy crystals from the blades. Further, swarms of gulls swooped down on the larger salps and picked out the nucleus (containing the stomach and the heart), leaving the victims to continue their slow, gliding motion as if nothing had happened. Moreover, many of the littoral animals greedily feed on the salps, even the little stony coral (*Caryophyllia*) having its soft tissues above the corallum distended to bursting with salps.

What the gulls and invertebrates delight in, surely fishes, and more especially herrings, do not despise, for, as first suspected by Dr. H. C. Williamson, long on the scientific staff of the Fishery Board for Scotland, and now on that of the Canadian fisheries, the herrings, less adept than the gulls in dissecting out the nucleus, swallow the salps—nucleus and all. Instead, therefore, of being a scourge, which swept the herrings from their wonted haunts, the salps would rather prove a welcome source of food.

W. C. McINTOSH.

#### Vernier Wireless Time-signals.

THE Colaba Observatory has had under regular observations the time-signals broadcasted from Eiffel Tower and Nauen. A good deal of confusion was sometimes caused when the Observatory clock, which showed almost perfect agreement with the ordinary signals (old system) transmitted from Eiffel Tower between 22 hr. 44 min. and 22 hr. 49 min. G.M.T., received here between 4 hrs. 14 min. and 4 hrs. 19 min. Indian Standard Time, showed a considerable difference, occasionally so much as 0.8 of a second, when compared about an hour later with the Nauen signals (international system), which end at Greenwich midnight. The rate of the clock is so small that during the interval of an hour the clock developed negligible error; the difference between the two stations was consequently considered unfortunate, although this difference was ordinarily small.

The question naturally arises what order of accuracy an observatory should attempt in its time determination. Both Eiffel Tower and Nauen transmit vernier time-signals which enable one to obtain very accurate comparisons, the probable error not exceeding 1/100 of a second, but if these two stations themselves differ by even 0.1 of a second, the accuracy attainable from the vernier signals becomes meaningless. As Eiffel Tower transmits the exact times of the first and the last of the series of 300 dots, and Nauen does not, and as Eiffel Tower time shows a better agreement with

Bombay time, greater reliance has been placed by the Observatory on Eiffel Tower signals than on the Nauen. It would be interesting to know the experience of other institutions in this matter.

S. K. BANERJI.

The Observatory,  
Bombay, April 9

THE question raised by Mr. Banerji is certainly important from the point of view of exact astronomy, but it is not new. It was fully discussed several years ago, and at Rome in 1922 the geodesists stated that field operations with small instruments in the open did not show anything like the large range shown by the fixed transit circles of the leading observatories. It was conjectured that the confined air in the transit circle rooms might cause some *lateral refraction through irregular stratification*. At a recent meeting of the Royal Astronomical Society Prof. Sampson put the discordances down to abnormalities in the level determinations, but the Astronomer Royal found it difficult to accept this suggestion. It appears from Mr. Banerji's letter that he has missed the earlier discussion.

Part of the difference between the different national observatories arises from the use of different solar tables, and consequent difference in the reduction from sidereal to mean time. This amounts to as much as 0.06 sec.

There is the further point that the daily time-signals necessarily rest on *preliminary* values of the instrumental errors. There is not time to discuss these fully before sending out the signals. The error from this source may approach 0.10 sec.

ANDREW C. D. CROMMELIN.

55 Ulundi Road,  
Blackheath, London, S.E. 3.

#### The Sound of Lightning.

CAPT. C. J. P. CAVE's letter in NATURE of May 23 reminds me of a storm at Little Shelford in 1915. I had waited for it to stop before I cycled in to Cambridge, and I started when there was clear blue sky in the zenith. An unexpected flash struck from the rear edge of the cloud before I had reached the garden gate, and damaged a tree within a hundred yards of me, near the village post office. The thunder was almost immediate, but was definitely preceded by a noise which I said was like "a sudden rending of calico"; Mr. Cave's "swishing" noise would also describe it. I was working on sound-ranging at the time, and thought the cause of the noise was probably analogous to the explosion wave, travelling faster than sound, which disturbs sound-ranging calculations for the last few yards of a gun's position.

W. LAWRENCE BALLS.

The Orchard House,  
Bollington Cross,  
Near Macclesfield,  
May 29

#### Hypothecate.

If a man prefers long words to short, who shall blame him? If he thinks Greek compounds more suited to the style of a learned paper, let us not hurt his dignity by carping. But we have a right to ask that he shall use such words correctly. Therefore it may be urged without offence that the many who like to write the word "hypothecate" when they mean "suppose" should first look that word up in the dictionary.

ONE WHO HAS DONE SO.

## The University of Bristol.

## OPENING OF NEW BUILDINGS.

ON June 9 their Majesties the King and Queen opened the new wing of the University of Bristol before a distinguished gathering of representatives of the city and surrounding counties. The magnificent tower (Fig. 1) and the new buildings were the gift of Sir George Wills and his brother, the late Mr. H. H. Wills, in memory of their father Mr. H. O. Wills, the founder of the University. The scholarly genius of the architect, Mr. George Oatley, upon whom the King has just conferred the honour of knight-hood, is revealed in every detail.

The building, with its imposing entrance hall, contains the main library of the Faculty of Arts and the extensive collection of medical works presented to the University by the Bristol Medical and Chirurgical Society. It also contains the whole of the administrative departments, the great hall of the University, with its hammered oak roof and carved oak panelling, the Senate and Council Room, as well as lecture rooms and private rooms for the whole of the members of the Faculty of Arts.

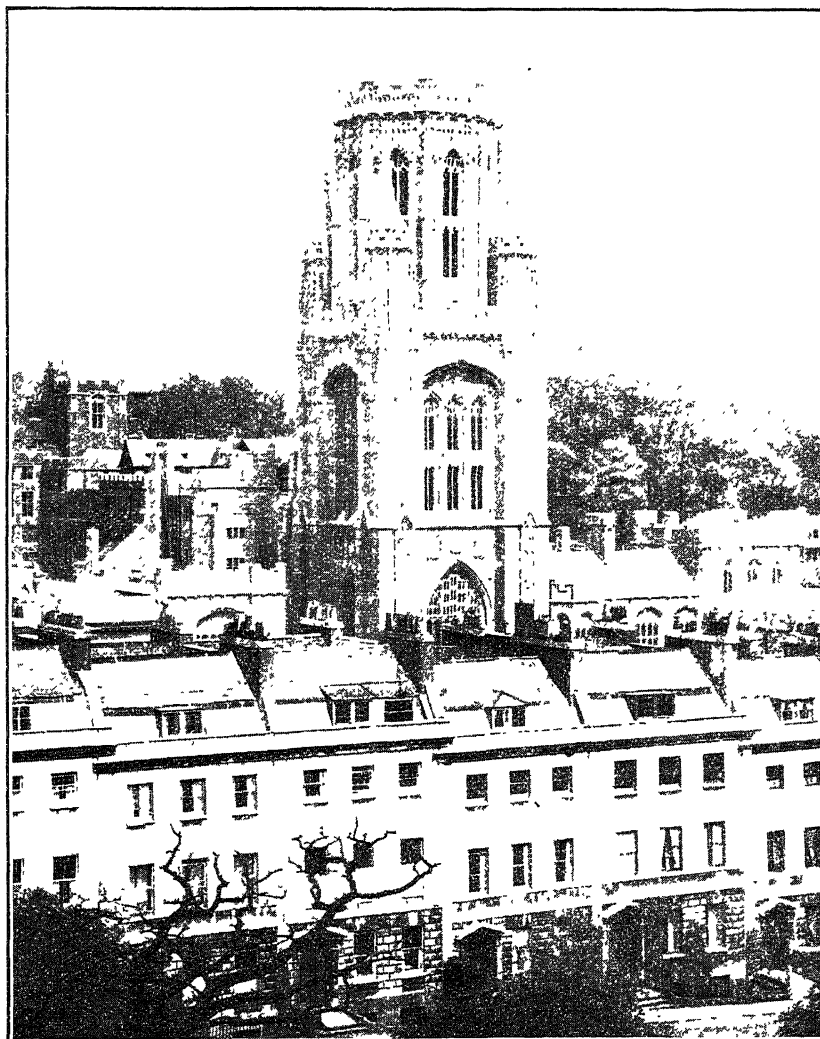
The University of Bristol, like so many similar institutions, arose from a University College founded in 1876, which was affiliated and later completely fused with the Bristol Medical School, founded in 1832. The University received its Charter in 1909. The Society of Merchant Venturers, which joined with the city in the petition for this Charter, gave its well-equipped engineering laboratories, and has since maintained the entire Faculty of Engineering as its gift to the common good. There are few institutions in Great Britain which can show such rapid growth in the brief period of sixteen years, part of which was occupied by a devastating war.

No sketch such as this can possibly pay personal tribute to the many administrators who laid the foundation or to the academic staff who created the reputation on which they built. There would have been no University had it not been for such men as Percival, Dean Elliott, Jowett, Temple, Procter Baker, Lewis and Albert Fry, Arrowsmith, P. J. Worsley, and H. Napier Abbot on one hand; and Rowley, Marshall,

Sollas, Silvanus Thompson, Lloyd Morgan, William Ramsay, Sydney Young, and Morris Travers on the other. It could not have come into being without the princely generosity of members of the Wills family, the financial assistance of the city of Bristol and the surrounding counties of Gloucester, Somerset, and Wilts, and the cities of Bath and Gloucester, all of which contribute from their rates.

The Science and Medical Faculties of the University are already housed in other buildings and further developments for various sciences are in progress. The recent removal of the Faculty of Arts to the wing

now officially open sets free a number of rooms adjoining the departments of geology, botany, and zoology into which they are expanding. That such expansion was a most pressing need can be realised by the fact that the chemical department, erected in 1910 and regarded at the time as not only complete but also adequate for all possible contingencies for thirty years, is now seriously overcrowded owing to the important schools of research it is called upon to accommodate. Still further relief will be afforded when the physics department leaves its present inadequate quarters and takes up its permanent home in the magnificent H. H. Wills laboratory in the grounds of the Royal Fort estate.



Photo]

FIG. 1.—The University Tower, Bristol, from Berkeley Square.

[F. Beech Williams

Again, the University has to thank the late Mr. H. H. Wills both for the estate and buildings. The erection of the physical laboratories on this commanding site has been progressing slowly but steadily, and they will be ready for occupation in about eighteen months. In this case also it would appear that provision is being made for its full growth for at least a generation, but the history of the chemical department leads any such statement to be received with caution.

The Royal Fort estate is beautifully situated on one of the highest points in Bristol; except for a portion now being used as an extension of the Botanical Garden and that occupied by the new physics buildings, no other sites have yet been earmarked, but it contains space for other departments which are certain to be wanted in the future, and these can be built without destroying the main features of the charming eighteenth-century residence and garden which forms a large portion of the estate, and so delighted the visitors who

attended the garden party held there on June 9 after the opening ceremony.

Another delightfully situated eighteenth-century residence, Clifton Hill House, was presented to the University in 1909 as a hostel for women students, and was extended in 1911 by the addition of the adjoining Callender House. At present the men are accommodated in Mortimer House and Canynge Hall, but in the near future a magnificent hostel is to be erected by Sir George Wills on the far side of the Downs on an estate presented to the University by Mr. H. H. Wills close to the athletic grounds at Coombe Dingle. Finally, the students and staff are fortunate in possessing a well-known landmark in the city, the Victoria Rooms, in close proximity to the University, where their Majesties had lunch on June 9. These fine buildings have been bought, endowed, entirely modified internally, and presented to the University for the purpose of a Club, by the same generous donor whose name will be forever remembered in the city of Bristol.

### Metal Resources and the Constitution of the Earth.

SPECULATION concerning the origin of ore deposits has been for many years, and is at the present time, dominated by the school of theorists who attribute a proximate and direct igneous origin not only to igneous segregations, contact deposits, and the metalliferous vein-deposits immediately associated with igneous intrusions, but to metalliferous veins generally. The grip attained by this theory is such that only rarely do authors of papers take a larger and more comprehensive view of either the possibilities or the actual facts of vein-formation. The extent to which the mind of the average worker is obsessed by the igneous theory is shown by the tendency to apply it in cases where it seems almost certainly inapplicable. In bedded iron-ores, sedimentary lead- and zinc-ores, and even petroleum, the igneous enthusiast sees clear evidence of metalliferous solutions and vapours rising through the earth's crust and effecting mineralisation at all levels on their way to the surface.

When igneous rocks are present anywhere within reasonable reach of metalliferous deposits, the igneous enthusiast is of course particularly happy. These igneous rocks may be miles away, but what does that matter? They may be entirely absent from the surface of a whole region; but that does not disturb his cheerful faith that somewhere the barysphere is bubbling. Indeed, at even shallower depths than the barysphere, are there not the seething metalliferous cauldrons of the magmasphere? The fact that both are well out of the way and far beyond the reach of observation comforts him rather than stirs his doubts, for on this account the barysphere and magmasphere are even more useful as a basis of speculation than they would be otherwise.

The notion that metalliferous veins have been deposited by solutions and vapours escaping from the barysphere was first made attractive by Posepny, and was freely adopted by students of ore genesis, partly on account of its simplicity and plausibility, and partly because it was regarded as the only alternative to the theory of lateral secretion, which had been found

wanting. Though simple and plausible, however, it is almost certainly false, and the geological case against it was very fairly stated by Le Conte, in his contribution to the discussion on Posepny's paper. In recent years the igneous theory has gradually assumed a form in which it is more acceptable to geologists, the seat of the juvenile metals being fixed, not in the barysphere, but in ordinary rock-magmas originating at comparatively shallow depths. In this form the igneous theory is just as simple and plausible as it was in the barysphere form, and it is more difficult to refute, although, as applied to most deposits, it is probably nearly as false; but if so, whence came the metals of the vein deposits and contact deposits so often associated with igneous intrusions?

This problem, which is not only interesting in itself on purely scientific grounds, but is also important in its bearing on metal resources, was considered by Sir Thomas Holland in his presidential address at the annual general meeting of the Institution of Mining and Metallurgy on April 23. The ground he took was the contrast between the small percentages of the less abundant metals in the earth's crust as a whole, and their percentages in ore deposits. Taking the average composition of igneous rocks calculated by Clarke and Washington (see *NATURE*, Aug. 19, 1922, p. 254) as the best data available, he pointed out that, according to these data, elements formerly regarded as rare, such as zirconium and cerium, are more abundant in the earth's crust as a whole than are the familiar base metals copper, zinc, lead, and tin. Again, nickel, which is produced in comparatively small amounts, is ten times as abundant as lead and some hundred times as abundant as tin.

Adopting the now apparently well-established view that the earth has a large core of nickel-iron, which is surrounded by silicate-rock shells decreasing in basicity from an inner shell of peridotite to an outer one of granite-gneiss, Sir Thomas Holland states that the natural home of the heavier metals is deep down in the core, and asks: "How then do they get to the surface

at all? Have they, since the earth settled down after Archæan times, been brought up in any appreciable quantity from great depths, or are we now dependent on the mere lateral segregation of small traces originally scattered residually through the outermost crust and left as the result of an imperfect gravitational adjustment when the earth passed from the molten to the solid state?"

Of the two rival theories, namely (1) that the metals have been brought from great depths in igneous eruptives, and (2) that the metalliferous deposits have been formed by the segregation of materials originally disseminated through comparatively superficial rocks, he remarks that they need not be mutually exclusive, and that they may be complementary; but after a consideration of the relative significance and merits of the two theories, he infers that only a small fraction of ore deposits show signs of transport from great depths, while the majority of those that are workable seem to be the result of simple lateral segregation, and even a large proportion of these are probably derived by segregation processes in the uppermost layers.

This view, which is probably the truth of the matter, so far as can be judged from the geodynamical evidence at present available, has an important bearing on the problem of the duration of supplies of metals. Supplies of lead, tin, zinc, and copper are likely to be exhausted long before those of coal and iron, and Sir Thomas Holland thinks it unjustifiable to take an optimistic view of the possibilities as regards aluminium, for bauxite deposits are few and small, and it remains to be proved that the metallurgical treatment of aluminium silicates is economically feasible.

In the concluding portion of his address he made some interesting remarks on the present condition of geology as a science. He clearly agrees with the editor of the *New York Engineering and Mining Journal-Press*, who told us recently that geological science is in the doldrums. Geological science, says Sir Thomas, is at present experiencing "a reposeful interlude"; it is indulging a "siesta." In his opinion the geological imago is more likely to emerge from its chrysalis stage at the meetings of the Institution of Mining and Metallurgy than at the meetings of the Geological Society. It would perhaps be wiser to expect any development that may affect geology as a science to be less sudden and spectacular than the emergence of an imago. The development is more likely to be gradual. Nothing could contribute more effectively towards the desired change than regular and joint meetings for discussion by the various societies interested. Is it too much to expect that the Geological Society, the Mineralogical Society, and the Institution of Mining and Metallurgy will one day establish permanent joint sessions and meet periodically, even if infrequently, to discuss topics of common interest? There is much uncultivated common ground between them. Dynamical geology, petrology, and mineral genetics require to be welded together into a scientific whole. By meeting periodically to promote the attainment of this end, each of the societies concerned would, while widening its own outlook, help forward the development of science. Now or never is the time to make this move, when three such able and intimate colleagues as Sir Thomas Holland, Prof. Watts, and Dr. Evans occupy the presidential chairs of the three societies chiefly concerned.

T. C.

### The Discovery of Benzene.

By Prof. JOCELYN F. THORPE, C.B.E., F.R.S.

IT is a fact not generally known that Faraday's early work at the Royal Institution was mainly of a purely chemical character and that it was not until later, about 1831, that he took up the study of electricity and magnetism, the branch of physics in which his more famous discoveries were made and with which his name is usually associated in the public mind. It is evident, of course, that this bent towards the chemical side of science was determined by his early association with Sir Humphry Davy, for Faraday has left abundant records illustrating the influence Davy's lectures and personality had on him. He seems to have first attended these lectures in 1812 when, as a youth of twenty-one, he was still serving as apprentice to Mr. George Riebau, a bookseller in Blandford Street; later he sent Davy a copy of the notes he had taken, together with a letter in which he expressed a wish to abandon trade and adopt a scientific career. It was well for posterity that this letter did not meet the same fate as that of a similar one sent to Sir Joseph Banks, then president of the Royal Society, which remained unanswered; for Davy sent a kindly and encouraging reply which not only led to an interview between them, but afterwards to the offer of a post as assistant at the Royal Institution,

the salary being 25s. a week with the use of two rooms at the top of the house; the minute of the Managers recording this appointment is dated March 1, 1813. Faraday did not, however, remain long at the Institution, for on Sir Humphry Davy relinquishing his appointment as professor of chemistry in 1813, Faraday accompanied him as secretary during a tour through Europe which occupied the next eighteen months.

It appears that Faraday had arranged with Davy prior to the tour that his post at the Royal Institution should be kept open for him, and to this he returned, in April 1815, being in the following month appointed "Assistant in the laboratory and mineralogical collection and superintendent of the apparatus at a salary of 30s. a week," apartments also being granted him. From this date onward until the end of what may be termed the first period, which closed with his illness in 1830, his work was almost entirely of a chemical character. His illness seems to have prevented him from doing active work for nearly four years, and thereafter he devoted his genius to the development of electricity and magnetism, and seems to have abandoned all work on the purely chemical side. Nevertheless, during the earlier period he made many important discoveries, for it seemed impossible for

this versatile man to touch any branch of science without enriching it. Indeed, the initial conception of many of the principles underlying colloidal chemistry, catalysis and the diffusion of gases was due to him.

Faraday's first original work was published in the *Quarterly Journal of Science* for 1816, and dealt with the analysis of native caustic lime. His own comment on this paper, printed in his volume on "Experimental Researches on Chemistry and Physics," is interesting, for he says: "I reprint this paper at full length; it was the beginning of my communications to the public, and its results very important to me. Sir Humphry Davy gave me the analysis to make as a first attempt in chemistry, at a time when my fear was greater than my confidence, and both greater than my knowledge; at a time also when I had no thought of ever writing an original paper on science." It is interesting to note, in view of the last remark, that during the next fifteen years he published as many as sixty important scientific papers, and that nine of these appeared in the *Philosophical Transactions*. An examination of the records shows, moreover, that he started his experimental work immediately on entering the Royal Institution, for in a letter to Benjamin Abbott dated April 9, 1813, that is, only about a month after his appointment, he described the work he and Davy had carried out on the composition of nitrogen chloride. During these operations both investigators seem to have received injuries from the many explosions that occurred, but with characteristic tenacity they succeeded in determining the specific gravity of the liquid and several of its properties.

One of the most striking of Faraday's earlier successes was obtained in his experiments on the liquefaction of gases, for in 1823 he was able to prepare chlorine, sulphur dioxide, carbon dioxide, sulphuretted hydrogen, euchlorine and nitrous oxide in the liquid state, free from water. The experiments were carried out at some personal risk, as the apparatus used was unsuited to withstand the pressure needed. He returned to this work twenty years later, and, adding cold to pressure, obtained ammonia, sulphuretted hydrogen, and nitrous oxide in the solid state. He had hoped to liquefy oxygen, and had subjected the gas to a pressure of 60 atmospheres at a temperature of  $-140^{\circ}\text{F}$ . without success. It was left to his successor to achieve this end, sixty years later, in the same Institution.

In 1821 Faraday was appointed Superintendent of the House and Laboratory at the Royal Institution, although it is curious that in a letter written to R. Phillips dated May 10, 1836, he states, "In the Spring of 1823 Mr. Brande was Professor of Chemistry, Sir Humphry Davy, Honorary Professor of Chemistry, and I, Chemical Assistant in the Royal Institution." Nevertheless, it is clear from the Managers' minutes that in February 1825 he was definitely appointed "Director of the Laboratory under the superintendence of the Professor of Chemistry." It was not until 1833 that he became the first holder of the Fullerton chair of chemistry. In 1820 he published the results of a most laborious and painstaking investigation on the alloys of steel, and in 1821 he described some new compounds of carbon and chlorine. In 1824, the year

in which he was elected a Fellow of the Royal Society, he undertook, at the request of a committee appointed by the president and council, an investigation into the properties of optical glass.

The year 1825 witnessed the discovery of benzene, the centenary of which is now being celebrated. It appears that the Portable Gas Company condensed oil-gas (from fish oil) at a pressure of 30 atmospheres. A thousand cubic feet of gas yielded about one gallon of liquid hydrocarbons, and from these Faraday isolated a substance he called bicarburet of hydrogen, identical with the benzene of to-day. The importance of this discovery and its effect on the work of later investigators cannot be overrated. It showed, for example, that benzene is a product of the decomposition of natural oils, and led, indirectly, to the discovery made by A. W. Hofmann twenty years later that benzene could be obtained by the distillation of coal-tar.

Probably no single discovery has had more effect on the development of the past hundred years than this, for it has led not only to the establishment of new industries in all parts of the world with the consequent employment of millions of workers, but has placed in the hands of every one materials hitherto either non-existent or obtainable only by the well-to-do. Dye-stuffs, perfumes, explosives, drugs, and similar modern commodities owe their existence to Faraday's discovery, because, once he had shown that a pure chemical substance could be produced by destructive distillation, the attention of chemists in all countries was directed to the possibility of obtaining others in the same way. Thus the isolation, in quantity, of benzene, toluene, the xylenes, naphthalene and anthracene from coal-tar was soon effected. Moreover, the influence which the discovery of the hydrocarbon had on the development of structural organic chemistry transcends that of any other substance, for benzene proved to be the keystone of "aromatic character" and the basis on which many natural products is built. The synthesis of natural indigo, to take one example of many, would have been impossible if benzene had been unknown.

It is true that Faraday had no idea whatever of the value of the discovery he had made. To him it was merely an interesting scientific fact which as soon as established ceased further to interest him. Indeed, things could not have been otherwise, because structural organic chemistry was then non-existent, and no one dreamt that there was any connexion between fish-oil and colour. But it is the pioneer who shows the way, even though he may not be able to or desirous of following it himself, and the sign-post erected by Faraday directed to a country full of rich and desirable things that could be utilised for the benefit of mankind. Fortunately, organic chemical science was served during the nineteenth century by a body of investigators who combined a clear and far-sighted vision with a manipulative skill which is the envy of their successors, and it was in their hands that Faraday's discovery was made to yield its full fruit.

In this way, therefore, one of the least of the discoveries of this great Englishman was destined to have a far-reaching effect on the civilisation of our race. Faraday, in a lecture delivered at the Royal Institu-

tion in 1816, spoke thus: "Before leaving this substance, chlorine, I will point out its history, as an answer to those who are in the habit of saying to every new fact, 'What is its use?' Dr. Franklin says to such, 'What is the use of an infant?' The answer of the experimentalist would be, 'Endeavour to make

it useful.' When Scheele discovered this substance it appeared to have no use, it was in its infantine and useless state; but having grown up to maturity, witness its powers, and see what endeavours to make it useful have done." Surely nothing better than this could be said of his own discovery of benzene.

### Current Topics and Events.

THE King's birthday honours list includes comparatively few names which are well known in scientific circles. Among them are the following: *Baronet*, Sir John Bland-Sutton, president of the Royal College of Surgeons; *Knight*, Prof. J. Robertson, Medical Officer of Health, Birmingham, and professor of public health in the University of Birmingham; *G.B.E.*, Sir Frederic Kenyon, Director and Principal Librarian of the British Museum; Sir John Snell, chairman of the Electricity Commission; *K.B.E.*, Dr. J. S. Flett, Director of the Geological Survey of Great Britain and the Museum of Practical Geology; *C.B.E.*, Dr. G. Rotter, Director of Explosives Research, War Office, Mr. F. A. Stockdale, Director of Agriculture, Ceylon, *O.B.E.*, Mr. W. Bevan, lately Director of Agriculture, Colony of Cyprus.

To an unsectarian gathering in connexion with the centenary meetings of the British and Foreign Unitarian Association, Lord Oxford and Asquith gave an address on "Some Phases of the History of Free Thought in the Nineteenth Century." From the contrasted lives of Robert Owen and William Cobbett, he illustrated the stimulus of free inquiry and open debate. Both men were pioneers in free and independent thinking, and Malthus was another who faced the facts careless of the hostility of his fellows. The search for truth continues to be the most imperious as well as the most stimulating of man's intellectual needs, and the form of the quest which we are accustomed to associate with the phrase "freedom of thought" is marked by independence of authority and by courageous facing of the facts wherever they may lead to in the way of conclusion. Freedom of thought marks the man of scientific temper though he may not have anything to do with what is conventionally called "science." Freedom of thought usually means the resolute exercise of scientific methods, but there is, as Lord Oxford indicated, a continual danger lest science become itself an authority that shackles freedom. Thus, he said, no greater misfortune has happened in the history of our vocabulary than that the same word "law" should be used to designate the command of a sovereign authority and the generalisations of a Newton or a Darwin. We wish that this lucid thinker had gone further in his analysis of what freedom of thought really means. Thus it is clear that, as secure scientific formulation advances, the field for freedom of thought must decrease. A formula that has stood the test of time and is verifiable by all normally constituted minds who can use the methods may be subsumed in a larger formula, but it can never be contradicted or scrapped. It is not the subject of legitimate free

thought. Much of the so-called free thought of to-day is the expression of ignorance and vanity.

THE Inter-State Post-Graduate Assembly of the United States and Canada is an organisation to which nothing in Great Britain precisely corresponds. More than 500 of its members were formally welcomed in London on June 2 by the Duke of York, at the commencement of a long round of lectures and demonstrations by distinguished members of the medical profession in Great Britain. A growth of no more than nine years, the Assembly at once emphasises a need which the advance of modern scientific medicine makes more and more urgent as time goes on, and goes far towards affording the means for its satisfaction. It is significant that Dr. Charles Mayo, whose name is so closely associated with the highest specialism, should be the mouthpiece of his fellow-American visitors, of whom 65 per cent. are men in contact with the people as general practitioners, and that on several public occasions during the past week he has deplored the over-luxuriant growth of specialism in medicine and urged the importance of the "common or garden variety" of doctor. There may be many things that our hospital wards, operating theatres and laboratories can show our American visitors for their professional good; but if they turn our attention seriously to the problem of co-operation between the highly trained specialist, in theatre or laboratory, whom Dr. Mayo calls the "accumulator," and the "distributor" of medical wares, they will have done as great a service to British medicine as any we can render to them. Sir Humphry Rolleston has done well to direct attention to the urgency of the problem of post-graduate education in London. The members of the medical profession, he says, are students all their days and are naturally most anxious to keep up with the ever-advancing tide of medical knowledge. But effective means for doing this in London have yet to be thought out.

It would be impossible to summarise here the many admirable papers read at the meetings of the Inter-State Post-Graduate Assembly. Some figures given by Colonel L. W. Harrison, of St. Thomas's Hospital, London, concerning venereal disease are, however, of general interest. Treatment during the last four years has reduced the new cases of syphilis from 42,000 to 22,000. New infections of gonorrhoea have diminished from 40,284 to 31,272. Although the number of attendances at clinics has increased, the cost has steadily diminished and in 1923-24 the estimate was 90,000*l.* less than in 1920-21, and the present cost is now 2½*d.* per head of the population.

The reverse side of the picture is seen in the difficulty of ensuring treatment for the infected, particularly among women; and it is still possible for many cases to occur in which a woman gives birth to one syphilitic child after another in miserable sequence.

SINCE the departure of Capt. Amundsen from Spitsbergen on May 21 no news has, at the time of writing, been received from the expedition. While some uneasiness may be felt, there are no adequate reasons for supposing that he and his party have met with disaster. He may have reached the Pole and landed on the ice in order to take observations, and then found it impossible to rise for lack of level ice. It must not be forgotten that his heavily-laden aeroplanes required a run of about fifteen hundred yards before rising in King's Bay. In this event he is retreating on foot to Cape Columbia in Grant Land, where there is the first of several food depôts by which he could reach Etah in Greenland by the end of October and, after wintering, return to Europe next year. On the other hand, it is not impossible that, contrary to expectation, Capt. Amundsen continued his flight across the Pole to the coast of Alaska. In this event, some weeks might elapse before news was received from him. Another possibility is that he has found an extension of the Canadian Arctic Archipelago on the American side of the Pole and that he is engaged in exploration before he returns by air. There is little likelihood of both machines having crashed, and their non-arrival may reasonably be taken to indicate that Capt. Amundsen has, for one reason or another, changed his plans. If he is travelling on foot, no anxiety need be felt for so experienced a polar explorer, for although the food he carried would last only about a month, he could doubtless get a supply of seal meat with the weapons he took with him.

In the pioneer work which led to the introduction of natural science into general school education, Clifton College played a very important part. At a time when chemistry and physics had not yet appeared upon the horizon of most schools, they were being taught at Clifton by men of the calibre of Profs. Debus and Worthington, Sir William Tilden and W. A. Shenstone, whose efforts were ably seconded by the then headmaster, Canon J. M. Wilson. When the present laboratories were erected, they were the best school laboratories in the British Isles. The rapid advances of the last thirty years, however, have rendered them inadequate and obsolete. The Council of the College has, therefore, decided to build a completely new science block, which seems likely to restore to Clifton its traditional position in the matter of accommodation for the teaching of science. The new buildings, which will stand on the site of the present Junior School, are to include two elementary and one advanced chemical laboratories, with similar provision for physics; a biological laboratory; four lecture rooms; research rooms for the head of the department and the senior physics master; a dynamo and battery room; a polarimeter room; a photographic dark room; a large science library; a physical geography room;

and mechanics' workshops, etc. It is hoped that the buildings will be ready for use by September 1927.

THE second annual Report of the International Committee for Bird Protection (British Section) is a three-page pamphlet which briefly records the subjects which have been dealt with. These include the destruction of birds on Macquarie Island (south of New Zealand), the threatened extinction of the magnificent parrots peculiar to certain of the Lesser Antilles, proposed international measures for the protection of migratory species, certain aspects of the still persistent traffic in plumage, and the destruction of sea-fowl by oil. This last subject also forms the subject of a separately printed statement by the chairman, Mr. H. S. Gladstone. It is one of great importance, for not only birds but also fishes and other forms of marine life, not to mention the amenities of seaside resorts, may be threatened; international agreement and firm action are urgently required. It may be mentioned that the Section consists of representatives of all the principal British societies and bodies interested in ornithological study or in the preservation of wild life.

MR. HOWARD CARTER, in his discourse at the Royal Institution on Friday, June 5, on "The Tomb of Tut-ankh-Amen, from Ante-Room to Burial Chamber," said that he proposed to deal mainly with the work of the second and third seasons. He gave a brief account of the Valley of the Tombs of the Kings and some aspects of the first part of the discovery, and then described the more important funerary furniture discovered in the burial chamber and shrines. This includes a unique palace lamp carved out of pure semi-translucent alabaster; a triple-lamp of floral design, which would appear to be the prototype of the three-branched candlestick of the Christian era; golden emblems of Anubis; a perfume vase of the King and Queen; a cosmetic jar still containing its cosmetic plastic and fragrant; and the gold stick of the king. An account was also given of the great yellow quartzite sarcophagus discovered beneath the four shrines, with its four winged goddesses, Isis, Nephthys, Neith and Selk, sculptured at the four corners in high relief, and of the golden coffin found within. This coffin, of anthropoid form, yet to be examined, is no doubt the outer shell of a series of coffins, one within the other, the last containing the mortal remains of the young Pharaoh Tut-ankh-Amen.

THE Swiss Society of Natural Sciences is holding its hundred-and-sixth annual meeting on August 8-11 at Aarau on the river Aar in Switzerland. The scientific proceedings will be distributed over sixteen sections devoted to various aspects of science, and a number of lectures are announced in the general programme. These include addresses by Prof. P. Karrer (Zürich), on cellulose and artificial silk; Prof. P. Niggli (Zürich), on the structure of crystalline material; Dr. E. Gagnebin (Lausanne), on Wegener's theory of the origin of the continents; Dr. E. Witschy (Basel), on sexual differentiation; Prof. L. Léger (Grenoble), on biological features of mountain streams; and Prof. A. Vogt (Zurich), on the significance in medicine of

research on inheritance. Excursions have been arranged to local places of interest. The president of the meeting is Dr. P. Steinmann, and the secretary, L. Kim, Aarau.

THE Italian Government and the International Institute of Agriculture have established a Joint Committee to organise a World's Forestry Congress, which will be held at Rome early in May 1926. Experts in forestry and representatives of the timber and allied industries are expected to attend from all parts of the world. The provisional programme of the Congress embraces a wide range of subjects, on which reports and papers will be read and discussed. This programme and the regulations may be obtained on application to the office of the International Forestry Congress, Villa Umberto, I, Rome (10). Persons of any nationality may take part in the Congress, as ordinary members, on payment of a subscription of 50 French francs, which will entitle them to a free copy of the proceedings and other publications issued by the Congress. At the same time there will be held, in connexion with the International Fair at Milan, an exhibition of forest products and of the machinery used in the conversion of timber, which should prove of great interest. Various excursions to Italian forests will be planned to follow on the conclusion of the meeting of the Congress.

THE thirty-sixth congress of the Royal Sanitary Institute will be held at Edinburgh on July 20-25. The Duke of York has consented to become honorary president, and the Right Hon. Sir John Gilmour, Bart., Secretary for Scotland, the president, will deliver his inaugural address on July 20. Already 675 delegates have been appointed from nearly 400 sanitary authorities from all parts of the British Isles; delegates will also be attending from Australia, India, South Africa, China, Egypt, France, Japan, the United States, New Zealand, Canada, Poland, and British West Indies. The meetings will be held in the University. The congress will meet in sections covering various aspects of sanitary science, and a number of conferences have been arranged. Among the subjects to be discussed are the Schick test and diphtheria, cancer, leprosy, and river and air pollution. The lecture to the congress will be delivered by Sir Leslie Mackenzie, and the popular lecture by Dr. Charles Porter. A Health Exhibition, including appliances for housing and general sanitation, and matters relating to health and physical welfare, will be held in the Waverley Market. Visits have been arranged to works and institutions in and around Edinburgh. The programme can be obtained from the Secretary, Royal Sanitary Institute, 96 Buckingham Palace Road, London, S.W.1.

THE science of protozoology—particularly that part of protozoology which deals with the parasites of man and animals—occupies such an important sphere in human organisation, that it is surprising that no journal devoted to its study has hitherto appeared in Great Britain. Protozoological papers have had to find a place either in periodicals of pure zoology or general medical parasitology, or else have

had to find their way abroad. There has now appeared, however, under the title *Protozoology*, a journal devoted to the parasitic Protozoa, published from the London School of Hygiene and Tropical Medicine, and the first number is already on sale. It is a publication of the Institute of Agricultural Parasitology, which is under the direction of Prof. R. T. Leiper, who is also responsible for the *Journal of Helminthology*; and it is intended primarily to supply a medium for the publication of original communications on the parasitic Protozoa arising out of the work of the Institute. At present it is proposed that it should appear as occasion arises as a supplement to the *Journal of Helminthology*. The first part contains an article by Dr. J. G. Thomson on a species of *Giardia* found parasitic in the intestine of a parasitic Nematode. A curious feature connected with this is that no Protozoa were found in the intestine of the host of the worm—a viscacha—although the gut of the nematode contained so many flagellates as to suggest a culture. Miss M. Triffett contributes a most interesting paper on *Gastrocystis gilvuthi*, a very common, though hitherto unsuspected, parasite of British sheep. The same author also has an article on various species of *Coccidia* found in snakes which were dissected at the prosectorium of the London Zoological Society. The articles are illustrated both by line-blocks and by half-tone plates. This new venture fills a very obvious gap in scientific literature, and we hope that it will meet with every success.

HIS Majesty the King will open the new house of the British Medical Association, in Tavistock Square, London, on Monday, July 13.

LORD BLEDISLOE, Parliamentary secretary to the Ministry of Agriculture, will open the new plant pathology laboratories at the Rothamsted Experimental Station, Harpenden, Herts., on Thursday, June 18.

DR. C. D. WALCOTT, secretary of the Smithsonian Institution, Washington, D.C., has been elected a foreign associate of the Brussels Royal Academy of Sciences.

WE regret to announce the following deaths:—M. Camille Flammarion, of the Observatory of Juvisy, Paris, widely known for his work and writings on astronomy, on June 4, aged eighty-three years; Mr. James Hunter Gray, K.C., a leading counsel in electrical, chemical and general scientific cases, on June 1, aged fifty-seven years; Prof. Omer Van der Stricht, professor of histology and embryology in the University of Ghent, on May 8.

WE learn from *Science* that the Thompson Gold Medal awarded by the National Academy of Sciences for distinguished service in the sciences of geology and palæontology has been given this year to Dr. John M. Clarke of Albany. The Medal, which was established for the purpose of recognising the achievements of long service, has been awarded but twice before, first to Dr. Charles D. Walcott, and second to Emmanuel de Margerie. Dr. Clarke was unable to attend the presentation ceremony on April 29, and it was

with much regret that we recorded his death in our issue of June 6, p. 882.

THE Science Society of China has issued a pamphlet describing its organisation and equipment with illustrations of its headquarters, including its large science library and biological research laboratory at Nankin. The Society was founded in 1914 by some Chinese students in the United States. It was incorporated in China in 1917 and since then has grown steadily, and now numbers more than 700 members. The Government gave it some buildings in Nankin as headquarters and it has also centres in Pekin and Canton, and is negotiating for the establishment of a research physical institute at Shanghai. It holds an annual conference in the summer, and has several useful committees on scientific education in China and on scientific terminology. It issues a monthly periodical entitled *Science*. The pamphlet is written wholly in Chinese.

AN innovation at the Royal Botanic Gardens, Kew, is the issue of interesting series of postcards, reproductions in colours from photographs of living plants in cultivation in the Gardens. The first four sets of this series, comprising twenty-four cards, are now available from the Publication Kiosk near Museum III. in the Gardens. With sets of six cards of similar subjects, such as insectivorous plants, orchids, rhododendrons, etc., descriptive folders are supplied, the set with description being issued at the very reasonable price of 1s. The descriptions supply brief notes upon distribution, points of particular botanical interest, and occasional notes upon cultivation. The experiment is an interesting one, towards the popularisation of the floral treasures in the Gardens, and the cards, which can be purchased separately if required, should have a ready sale.

THE report of the National Illumination Committee of Great Britain for the year 1924 is concerned mainly with proceedings at the meeting of the International Illumination Commission, held in Geneva in July last. A list of definitions and symbols adopted at this meeting is given in the report, and it is mentioned that sub-committees on heterochromatic photometry, colorimetry, and a vocabulary dealing with illumination have been appointed. It is interesting to observe that the International Illumination Commission has approved in principle the adoption of the brightness of a black body, operated under specified conditions, as a primary standard of light, and the National Physical Laboratory has been asked to formulate suggestions for an accurate specification. International sub-committees dealing with the lighting of factories and schools and motor-car headlights have also been formed. Attention is also directed to the establishment of a sectional committee on illumination by the British Engineering Standards Association. Five sub-committees dealing respectively with photometers, nomenclature and symbols, illumination glass-ware, fittings and street lighting have been set up and are now holding meetings.

THE Report of the United States National Museum for 1924 records the accession of 362,942 specimens,

this being well above the average (332,429) for the last fifteen years. The increase was particularly marked in the biological accessions and its value was enhanced by the scientific importance of many of the collections. Chief among these was the private collection of Dr. J. M. Aldrich, associate curator of insects, containing 44,610 specimens of Diptera, representing 4145 named species with type-material in 534 species. But in one way more notable was the transference to the National Museum of all the insect type-material in the custody of the Pennsylvania Department of Agriculture, comprising the holotypes of 14 species, cotypes of 6, and paratypes of 35. It is hoped that this example will be followed by other States, for, as it is justly urged, type-specimens deposited in a national museum are more accessible to specialists than when housed in State, or municipal, or private institutions, and are much safer since there is less likelihood of a change of policy. It may be added that the fewer the centres in which such material is assembled, the greater is the advantage to the serious student.

WE have received a copy of the second report of the Joint Benzole Research Committee of the National Benzole Association and Leeds University (1925). The report is divided into two sections, the first treating of the corrosion of brass and copper by benzole, and the second of the use of active carbon and silica gel for the recovery of benzole from coal and coke-oven gas (Bayer process). A complete bibliography for the years 1923, 1924 is included.

THE journals of F. Martens, the seventeenth-century naturalist traveller, are being republished by Dr. W. Junk, Berlin. His journey in the year 1671-1672 to Spain and the Canary Island was of less importance than earlier journeys to Greenland and Spitsbergen, but it enabled him to make a number of valuable observations. The journal is illustrated by many beautifully executed plates of scenery, plants, and fishes, but the editor has not added any notes.

No. 47 of the Bulletin of the National Research Council of the United States consists of a classified list of Bibliographies of Physics published either as separate bibliographies or more commonly as references in books or in articles in scientific periodicals during the years 1910-22. The list has been compiled for Research Information Service by Dr. K. K. Darrow, of the Research Laboratories of the American Telephone and Telegraph and the Western Electric Companies. It has been found undesirable to follow the system of classification adopted in the International Catalogue of Scientific Literature, owing to the number of new subjects of investigation which have been opened up since that system was devised. Thus relativity, quantum theory, and radioactivity are included in the general physics, while the properties of  $\alpha$ ,  $\beta$ , and  $\gamma$  rays are treated under electricity. Where the bibliographical value of a book or an article is high, an asterisk is prefixed. As an example of the extent of the list, we may mention the section on X-rays, which covers 3 pages, and is

classified under 20 headings. The whole list covers 95 pages and is followed by an index of 6 pages.

THE Cambridge Instrument Co., Ltd., is issuing convenient sized booklets describing the latest types of instrument which the firm produces. Booklets Nos. 3 and 4 are devoted to direct current and alternating current instruments respectively. Wherever possible, sensitivity data accompany the descriptions, and will prove helpful to intending purchasers. The figures given are not necessarily the best, but are those which can be easily obtained. A new form of Duddell oscillograph is described. It is easily portable and enables three simultaneous records to be obtained although only one source of light and one camera are required. Another novelty is the Campbell frequency meter. It should be of value in telephone work, as it enables accurate measurements of frequencies between 180 and 4000 cycles per second to be made. The condition of balance is indicated by silence in a telephone, and the frequency is found by multiplying the reading on the scale by a simple factor, depending on which of the five ranges is used. Various types of apparatus suitable for telephone engineers are made, and electrical engineers will be interested in the fault localiser, the lightning conductor bridge, and the Epstein testing square.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: a lecturer in mathematics and mechanics at the Stockport Technical School—The Principal (June 24). Three assistant inspectorships in connexion with agricultural, dairying, and horticultural education and research (two with practical experience in agriculture and who have specialised in dairying, and one who has specialised in horticulture)—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (June 29). An assistant chemist at the Fruit and Vegetable Preservation Research Station of the University of Bristol, at Campden, Glos.—The Registrar, University, Bristol (June 29). A microscopist at the Technological Research Laboratory of the Indian Central Cotton Committee, Bombay—The Secretary, Indian Central Cotton Committee, 25 Wodehouse Road, Fort, Bombay (July 5). An assistant in biology at University College, Galway—The Secretary (September 18). Assistant entomologists under the Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1. Keeper of the laboratory of the Royal Horticultural Society at Wisley—The Director, R.H.S. Gardens, Wisley, Ripley, Surrey.

### Our Astronomical Column.

ORKISZ'S COMET.—Prof. Banachiewicz and his assistants have made a careful study of the orbit of this comet, using 80 observations extending from April 3 to May 27.

T	1925 April 1.4782 G.M.T (new)
$\omega$	$36^{\circ} 9' 15''$
$\Omega$	$318^{\circ} 3' 11''$
$i$	$100^{\circ} 0' 46''$
log $q$	0.04505

Actually they give the elements not in the above form, but in *Cracovians*, a name that they have given to the direction cosines of the major and minor axis of the orbit, and the normal to the orbit plane. It is shown that some of the computations are simplified by using this form. No appreciable deviation is found from a parabola, so identity with the comet of A.D. 1500 is excluded. The following outline ephemeris is given:

	R.A.	N. Decl.
June 4.	$6^h 15^m 57^s$	$81^{\circ} 38'$
July 6.	$10 10 15$	$60 57$
Aug. 7.	$10 54 24$	$47 49$
Sept 8.	$11 23 55$	$40 11$

THE KODAIKANAL OBSERVATORY IN 1924.—The report of the Kodaikanal Observatory for the year 1924 emphasises the importance of this observatory for solar work. Photographs on a scale of 8 inches to the sun's diameter were taken on 328 days. Monochromatic images of the sun's disc in K light were obtained on 329 days, prominence plates on 290 days, and photographs of H $\alpha$  disc plates on 294 plates. Three important features are brought out on the last-mentioned plates, which appear to be typical of sunspot disturbances. An account of these was recently presented to the Royal Astronomical Society by Dr. T. Royds. They are (1) a bright ring round the sunspot; (2) outside this a dark flocculus more or less extensive; and (3) between the dark flocculus and the coarse réseau of the general undisturbed surface of the sun there is a bright narrow band consist-

ing of bright patches larger than in the general réseau, interspersed by dark features sometimes suggestive of the spot vortex. The study of these phenomena is being continued. The sunspot activity showed a steady increase since the previous year, the approximate mean latitudes of the spots being  $23^{\circ}.7$  in the northern hemisphere and  $24^{\circ}.9$  in the southern. In the laboratory a series of comparisons of the solar spectrum with arc spectra was obtained for subsequent measurement for displacement of the solar lines.

SPECTROSCOPIC PARALLAXES.—It is interesting to note that the Stonyhurst College Observatory has published its first paper on spectroscopic parallaxes (Monthly Notices R.A.S., vol. 85, p. 444), and the author, the Rev. H. Macklin, gives the values for 30 stars. He explains that as only stars not fainter than about the third or fourth magnitude gave spectra intense enough for this purpose with the Stonyhurst instruments, sufficient material is not yet available for more than a preliminary examination. The intensity-differences between the lines are measured by a wedge, the method adopted by the Norman Lockyer Observatory. At the latter observatory the luminosities and spectroscopic parallaxes of 1025 stars of types Fo to Mb, and 200 stars of type B, have already been published, the last 100 B-type stars appearing in the same issue of the Monthly Notices.

NEW LUNAR MAP.—Mr. H. Percy Wilkins has in preparation a lunar map of 200 inches in diameter in sheets of  $22 \times 30$  inches. The detail is taken from all published drawings and notes, namely, Weinck, Elger, Gaudibert, Goodacre, Schmidt, and photos from Paris, Lick, Yerkes, and Mount Wilson. Objects down to half a mile in diameter are included. The sheets will be issued separately, so that any one requiring, say, the sheet containing Plato can have it without the others.

## Research Items.

**NEOLITHIC AGRICULTURAL IMPLEMENTS FROM CHINA.**—In *L'Anthropologie*, T. 35, Nos. 1-2, P. Licent and P. Teilhard de Chardin describe two stone implements from an important neolithic site at Linn-Si, N.E. China, which are not only noteworthy in themselves but have a direct bearing upon a question of dating raised by Dr. Andersson in connexion with an implement found at Kalgan. The two implements in question are respectively 272 mm. long, 115 mm. broad, maximum thickness 16 mm.; 355 mm. long, 117 mm. broad, maximum thickness 26 mm. The latter differs from the former in being polished. Certain well-marked abrasions suggest that both were fitted with handles, and it is probable that they were used as hoes. The implement found by Andersson, which resembled the unpolished implement from Linn-Si, impressed him by its Solutrean style, and he suggested that it might point to an upper palaeolithic in China; but it is now clear that it must be classified as neolithic. A further point which emerges is the close affinity of these agricultural implements with those of North America. This had already been pointed out by Andersson in the case of the Kalgan implement, and is supported by Mr. Moorehead after an inspection of the Linn-Si specimens. They may therefore afford further proof that North America was peopled from Eastern Asia.

**PHYSICAL CHARACTERS OF THE AUSTRALIAN ABORIGINES.**—Dr. F. Wood-Jones and Dr. T. D. Campbell have published in the Transactions of the Royal Society of S. Australia, vol. 48, anthropometric observations, comprising thirty-five measurements in all, of ten South Australian aborigines: eight Kookata from the Stuart Ranges, of whom three are females, and two, a male and female, Ngunga from Streaky Bay. The skin colour varied from light to very dark chocolate, the eyes were dark or medium brown, the hair was black (except in two cases in which it was white) and wavy, though in two cases approaching straight. The head in length ranged from 165 to 200 mm., breadth from 130 to 146 mm., being dolichocephalic in all cases, and in height from 112 to 135 mm. To these measurements have been added measurements from various sources which bring the total number of individuals up to nearly two hundred. As a result of the comparative study of these figures, so far as at present completed, it is apparent that the Australian aboriginal is uniformly dolichocephalic, remarkably platyrrhine, has long forearms, and remarkably long legs from the knee downwards.

**THE TRICHOCYSTS OF PARAMECIUM.**—Mr. J. T. Saunders (Proc. Cambridge Phil. Soc., Vol. I., No. 4, April 1925) has investigated the trichocysts of *Paramecium* and concluded that they are the means by which this ciliate adheres to surfaces. When *Paramecia* are attracted, chiefly by the  $P_{\pi}$  of the water, to a particular spot, adherence takes place. The extrusion of the trichocysts is due to slight pressure such as may be set up by the *Paramecia* colliding with an object in the water. Verworn's view that the trichocyst consists of semi-liquid material which hardens on being extruded into water is adopted. The author shows that the tip of the trichocyst thread is sticky but the rest of it is not. Ciliary motion does not cease when *Paramecium* is attached by its trichocysts. The speed of movement, which is dependent on ciliary activity, is reduced when the  $P_{\pi}$  of the water reaches 8.0, and this reduction in ciliary activity results in the slender trichocysts being able to hold

the organism fast. A further increase in the  $P_{\pi}$  of the water above 8.0 reduces the speed of the *Paramecium* so much that the force of the collision with an object is insufficient to cause expulsion of the trichocysts.

**GOLGI APPARATUS, MITOCHONDRIA AND NUCLEI**—Dr. R. J. Ludford (Journ. R. Microsc. Soc., March 1925) describes an improved technique the new feature of which is the employment of water at 35° to 38° C. for bringing about the reduction of osmic acid for demonstration of the Golgi apparatus. Dr. Ludford states that this method results in much less non-specific reduction than when the osmic acid is heated. The original paper should be referred to for details.

**A GENETICAL STUDY OF THE FLAX PLANT**—A beautiful example of the application of pure science to practical problems is supplied by the very clear paper of Adelaide G. Davin and G. O. Searle, which appears in the Journal of the Textile Institute, Vol. 16, pp. T. 61-82, March 1925. As the result of extensive correlation studies they conclude that by ordinary selection methods it should be possible to isolate varieties of flax which are genetically distinct as to (1) flower colour, (2) time of flowering, (3) percentage of fibre, (4) length of stem, and (5) mean number of seeds per capsule. Also that it should be possible to breed new varieties of flax combining the qualities of tallness, high percentage of fibre and high mean number of seeds per capsule. From the practical point of view perhaps the most important facts appear to be the inheritance of variations in percentage of fibre and the fact that tall stemmed varieties contain more numerous fibres in each bundle of sclerenchyma, the fibres therefore being individually of relatively small diameter and with small open lumen. Probably such bundles of fibres have particularly valuable spinning qualities.

**DROUGHT-RESISTANCE OF PLANTS.**—It has been supposed that xerophytic plants are able to resist drought mainly by the reduction of their transpiration through special adaptations, such as hairs, thickened epidermis, and so on. N. A. Maksimov has studied the problem for several years, and according to him (*Journal of Experimental Agronomy*, Moscow, vol. 22, 1923) this is not the case. He has found, in fact, that the transpiration of xerophytes is, as a rule, far more extensive than that of typical mesophytes. Thus, xerophytes cannot be regarded as being able to thrive under very dry conditions because of adaptations preventing loss of water through transpiration. Their ability to resist drought depends not on their morphology or anatomy, but on some purely physiological characters. Amongst the latter most important are: (1) the high osmotic pressure of the juice in cells causing a powerful influx of water through roots; (2) the probable presence of special compounds preventing plasmolysis; (3) wilting of xerophytes occurs with a lower water-content than in mesophytes.

**THE MORPHOLOGY OF THE CARPEL.**—The traditional interpretation of the gynoecium of the flower as simply consisting of the union of modified carpellary leaves, by their margins when the ovules are parietally borne, by their folded flanks when the placentation is axile, with alternative suggestions as to the axial or carpellary origin of the central strand when this is left free from the ovary wall, is now under serious critical examination, thanks to the work of Miss Edith R.

Saunders In a paper upon carpel polymorphism in the *Annals of Botany*, vol. 39, 1925, pp. 123-167, Miss Saunders gives reasons for thinking that widespread throughout the group of Angiosperms three different types of carpels can be found, all of which contribute to the making of the Angiosperm gynæcium. She distinguishes these three types as—(1) the valve carpel, which retains the traditional leaf form, a row of ovules being borne upon each foliar margin; (2) the solid carpel, which in its most reduced form is nothing but a fibro-vascular cord with a few lateral veins. (Such a carpel may project into the ovary cavity, giving rise to such a partition as the replum of the Cruciferae. When solid carpels are associated with valve carpels in a gynæcium, they are usually fertile and the valves sterile); (3) the semi-solid or pseudo-valve. In this type the valve contour is maintained, but the placenta, instead of lying at the margin, are displaced to the neighbourhood of the central line and the vascular system also consists of a double strand running in close connexion with the funicles of the ovules. Many anomalies of stigmatic and stylar structure and arrangement receive a new interpretation at Miss Saunders' hands by means of these new conceptions of polymorphism in carpellary structure. Doubtless this new view-point will be thoroughly examined by students both of floral morphology and systematics.

THE DISTRIBUTION OF RADIOACTIVE SPRINGS.—Seventeen springs in the Velay region of the Haute-Loire have been examined by M. A. Baldet (*C. R. Acad. d. Sci.*, Paris, March 30), who found that only three of them showed any considerable radioactivity. The three streams in question lie practically in a straight line, the length of which is 44 km.; and more recently a fourth radioactive spring has been discovered, in the former bed of a stream the course of which has been diverted by floods. The new spring lies in the same straight line as the other three, so that it seems very probable that the distribution is not fortuitous, but that there is really a kind of long geological axis along which the strongest radioactivity of the region is distributed. This axis is nearly parallel to numerous lines of fracture in the surrounding country and to two ranges of volcanic hills. An extinct volcano lies on the axis near one of the springs, as do portions of two river valleys.

SPELLS OF ABNORMAL WEATHER.—The presidential address to the American Meteorological Society by Mr. Willis I. Milham dealt with "The Causes of Abnormalities," taking especially the year 1816, which in America has been styled "the cold year," and is often called "the year without a summer." The address is printed in the *Monthly Weather Review* for December. Much has previously been written about this year, which, as a whole, is said not to have been "record-breakingly cold," but was chiefly exceptional for a very cold summer. The possible reasons why 1816 was abnormal are considered. There had been the violent volcanic eruption of Tombozo in April 1815, which ranks with the four or five largest during the last two centuries, while a weak sun-spot maximum also occurred during 1816. For the 23-year period 1816-1838, July 1816 had the lowest temperature on record and both May and June were the second coldest, while from March to September the monthly temperatures were below the normal. For another abnormality the warmth in America of December 1923 is considered, and it is suggested that possibly some change in ocean-surface temperature over a large area was the cause. At Greenwich, December 1923 was about 1° colder than the normal. Mr. Milham alludes to the "crying need for a weather map of the whole

northern hemisphere, if not for the world." For some years now, 1910-1917, such weather information for the world has been published by the Meteorological Office, Air Ministry. In support of Mr. Milham's address it may be mentioned that in London the mean shade temperature in 1816 was 53° F. in June, or 5° below the normal for 150 years, 54° 5 F. in July, 7° below the normal; and in May and August the deficiency was respectively 3° 6 and 3°. The July mean was the lowest on record. June 1909 and 1916 are the only two Junes with temperatures so low as that of 1816. In every month during 1816 except September and October the mean temperature in London was below normal.

COLOUR CINEMATOGRAPHY.—Mr. Claud Friese-Greene recently described his process of colour cinematography before the Royal Society of Arts, and his lecture is printed in the Society's *Journal* for May 1. It is a two-colour process, and the two colour images alternate on a single film, so that ordinary projecting machines suffice for showing them. An ordinary motion picture camera has added to it behind the lens a rotating disc with two apertures in it, one filled with a colour filter that passes a very broad band of the red end of the spectrum, and the other filled with an opaque material except for a small opening that allows white light to pass and a "small portion of filter also passing light from the red end of the spectrum"—"in fact a pale yellow." In the positive print, the pictures corresponding to the first are dyed orange-red and the others are dyed blue-green. The advantages of the method are that the tendency of greens to show of a brownish tint in two-colour processes is avoided, the cost of the prints is less than one farthing a foot more than that of ordinary black and white films, and "the time in turning them out" is practically the same. Several examples were shown, and during the discussion that followed the lecture Mr. Colin Bennett said that "the results were appreciably better than those arrived at by other commercial methods of colour cinematography."

PHOTO-ELECTRIC CONDUCTIVITY IN ROCK SALT.—The phenomena of photo-electric conductivity in rock salt crystals which have been coloured yellow by the action of X-rays, are similar in many respects to those which have been observed in the diamond and other crystals with high refractive index. They are described by Dr. B. Gudden and Dr. R. Pohl in the *Zeitschrift für Physik* of March 17. Their observations were made in an electric oven, at temperatures of 30° to 40°, 60° to 80°, and 100° to 130°, the crystal being illuminated with light of short wave-length (405 and 436 mμ lines of mercury) with a potential difference of 800 volts applied to the electrodes. At the lower temperatures the crystals are insulators when not illuminated. The current starts without inertia as soon as the illumination commences, and drops at once nearly to zero when it ceases; this current is regarded as being due to the flow of electrons which have jumped from the phosphore particles, after absorbing radiant energy, leaving them in the excited state. If now the crystal is illuminated with infra-red light, there is a rush of current, which quickly drops to a low constant value; this is regarded as being due to the drop of electrons, coming from the cathode side, into the positively charged phosphore molecules. At the higher temperatures this action is facilitated by the thermal movements of the molecules, and at 100° to 130° there is practically no jump in the current when the red illumination is started, since there are no excited centres left when this takes place. Phosphorescence takes place when the second component of the current flows.

**REFRACTIVE INDEX OF A MIXTURE.**—Although there have been many attempts to establish a formula by means of which the refractive index of a mixture of two liquids could be calculated from the indices of its constituents and the amounts of each present in the mixture, none of them has been found applicable to all cases. In the issue of the *Physikalische Zeitschrift* for April 21, Prof. K. Lichtenecker claims that if the mixture involves no contraction, its refractive index  $\mu$  may be calculated from the refractive indices  $\mu_1, \mu_2$  of its constituents and the volumes  $v_1, v_2$  of the constituents present in 1 c.c. of the mixture by the formula

$$\log \mu = v_1 \log \mu_1 + v_2 \log \mu_2.$$

If contraction occurs on mixture, the value of  $\mu - 1$  as calculated from this formula is increased in the ratio of the increased density to the density to be expected on the linear law from the densities of the constituents. So far, the new law has been tested on few mixtures, but for them it has proved correct to within one part in 10,000.

**MEASUREMENT OF IONIC MOBILITY.**—The April issue of the *Journal of the American Chemical Society* contains two papers by D. A. MacInnes and co-workers on the measurement of transport numbers by the moving boundary method. In the first paper a simple form of apparatus is described in which two sharp boundaries are readily obtained at each electrode; the apparatus is very suitable for use in university courses. Experiment shows that the results should be calculated from rates of movement of the two boundaries separately; it is not safe to rely on the ratio of the movements. In the second paper the apparatus previously described is improved and measurements made of the transport numbers of the anions in 0.1*N* solutions of potassium, sodium, and hydrogen chlorides. The results were 0.492, 0.3865, and 0.8320, respectively. The product of the transport numbers of the chloride ion and the corresponding equivalent conductivities for the solutions is constant, which shows that the salts in these solutions have equal degrees of dissociation at 25°. Previous work shows that the same holds at 18°. This dissociation is considered to be complete, so that the influence of concentration on equivalent conductivity is due to changes in mobility rather than in the number of ions.

**ORGANIC SYNTHESSES.**—The suggestion has been made that "Organic Syntheses," an annual publication of satisfactory methods for the preparation of organic chemicals, can increase its scope of usefulness by making available directions for preparations which have been submitted for future volumes. The following is a list of some of the preparations which are now being checked by the editors. Those who wish a copy of directions for some of the listed preparations can procure the same by writing to Henry Gilman, Iowa State College, Ames, Iowa. Acetamidine, acrolein, benzal pinacolone, benzylaniline, *m*-bromobenzyl chloride, *o*-bromotoluene,  $\alpha$ -cyano- $\beta$ -phenylacrylic acid, cyclohexyl-bromopropene, furoic acid, hydroxylamine base, *p*-iododimethylaniline, *p*-iodoguaiacol, mandelic acid, 1-methyl-2-pyridone, myristic acid, naphthaldehyde, phenyl isothiocyanate, symphthalyl chloride, propionaldehyde, pyromellitic acid, pyrrol carboxylic acid, thiophosgene, thymoquinone, *o*-toluamide, *m*-tolylene diamine, viscose.

**MEASUREMENT OF RADIO SIGNAL STRENGTH.**—The first accurate measurements of radio signal strength were made so far back as 1905 by Duddell and Taylor. An immense amount of experimental work has since been carried out all over the world. Many semi-

empirical formulæ have been suggested for predetermining the signal strength, but they only apply roughly for a given range and for a given wavelength. An important paper on this subject by Capt. Round and his colleagues in the Marconi Co. was read to the Institution of Electrical Engineers on May 6. They give a complete report of the measurements made on signal strength over great distances during 1922 and 1923 by an expedition sent to Australia. They apply the latest scientific formulæ to their observational data, but with only very indifferent results. The complete theory of world transmission by radio has yet to be given. It is pointed out that at great distances the signals go round the earth in both directions, producing interference and "beats" in the receiver. The attenuation of the signals is less during night time, and so a louder signal may come by the long path. For example, with the American signals a bi-directional effect was clearly produced at a distance of only 13,000 kilometres from New York. A study of the Australian signal measurements leads to interesting conclusions. It was found that, in general, when using long wave-lengths, the signals going by the west to east path were stronger, and those going by the east to west path were weaker, than was expected. In the case of the Bordeaux signals the ratio was 5 to 1. In the case of transmission across the Atlantic, transmission from America to England is undoubtedly better than transmission in the reverse direction. This fact appears to contradict the usual reciprocal relations of optical theory, and the authors look to the future for the observational data still requisite before the phenomenon can be explained.

**MEASUREMENT OF WATER DISCHARGE THROUGH SLUICES.**—There has just been issued, in booklet form, two papers, by Dr. H. E. Hurst and Mr. D. A. F. Watt, of the Physical Department, Egyptian Public Works Ministry, presented to the Institution of Civil Engineers, in 1924, dealing with the measurement of the discharge of water through the sluices of the Assuan Dam. The first paper details certain experiments made to determine the similarity of the motion of water through sluices and through scale models, and the second is a record of actual measurements of the Nile during its higher stages made by a method depending ultimately on direct volumetric computation by means of a masonry tank. In the first paper, the authors conclude that the discharge of large sluices can be determined from models with an average accuracy as good as that obtainable by current meter measurements, the scale of the model to be adopted depending upon the product of the velocity in the actual sluice and its linear dimensions. They state that the limit of smallness in their investigations occurred with weir conditions when the head above the sill was about 3 cm., the depth about 2 cm. at the gate, and the velocity about 0.4 m. per sec. They suggest that until further experiments are made over a wider range, it would be well to keep the product of velocity, in centimetres per second, and smallest dimensions of the orifice, in centimetres, above, say 100, and in general not to use orifices of less than 3 cm. in their smallest dimension. In the second paper, it is stated that the method employed for measuring the flow of the Nile was to use current-meters of specially stout construction to plot the velocity-distribution in the types of sluice used to pass the flood. Useful results were obtained which showed that current meter measurements agree closely with sluice measurements, and, therefore, that the uncertainty about the correctness of current meter results in a deep and rapid stream is largely removed.

The Origin of Species as revealed by Vertebrate Palæontology.<sup>1</sup>

By Dr. HENRY FAIRFIELD OSBORN,

Senior Geologist, U.S. Geological Survey; Hon. Curator Vertebrate Palæontology, American Museum of Natural History; Research Professor of Zoology, Columbia University.

"Discussions of evolution came to an end primarily because it was obvious that no progress was being made . . . We became geneticists in the conviction that there at least must evolutionary wisdom be found. . . . The discontinuity of variation was recognised in abundance. Plenty of the Mendelian combinations would in nature pass the scrutiny of even an exacting systematist and be given 'specific rank'. In the light of such facts the origin of species was no doubt a similar phenomenon. . . . We cannot see how the differentiation into species came about. Variations of many kinds, often considerable, we daily witness, but no origin of species . . . That particular and essential bit of the theory of evolution which is concerned with the origin and nature of *species* remains utterly mysterious" (William Bateson: *Evolutionary Faith and Doubts*). Address in Toronto, December 28, 1921.)

IN the early part of the nineteenth century the geologists Hutton and Lyell, the masters of Darwin, overthrew the cataclysmic hypothesis of earth formation by the new uniformitarian doctrine in geology, "We must interpret the past by the present." Now is the time in biology to reverse this doctrine and demonstrate that we must *interpret the present by the past*. This we owe to the discovery of continuous genetic phyla of both invertebrate and vertebrate animals, in which the evolution of the germ-plasm can be continuously traced.

As distinguished from all observations in zoology, we deal in palæontology with secular evolution, *in which we observe the adaptive action and reaction of the heredity germ over long periods of time*. We also observe the secular action of natural selection (Darwin's selection factor), the secular direct reaction to environment (Buffon's factor), the secular adaptive action of habit (Lamarck's factor), the secular adaptive reaction to the living environment (Darwin's factor). As developed between 1893 and 1915 by Osborn, we must sharply separate Darwin's factor of selection, which has no energy content, and the above four energetic forces of evolution, namely, heredity, physical environment, living environment, and individual development or ontogeny.

Every organism develops through the normal interaction of these four forces; if either force is not normal the organism is not normal; if either force is progressive the organism will tend to be progressive; if either force is retrogressive the organism will tend to be retrogressive in the same manner. Whereas in the transmutation of chemical elements and evolution of form in all the inorganic universe we have to do only with the action, reaction, and interaction<sup>2</sup> of internal forces and external forces, in the transmutations of life we have to do with these *four* complexes of energy: first, the internal potential energy of heredity as observed in phylogeny; secondly, the internal energy of the developing organism as observed in ontogeny; thirdly, the external energy of the physical universe

known as environment; fourthly, the rapidly multiplying energy of surrounding plant and animal organisms, known as the biota. From the beginning of life every typical organism is invariably developed under this quadruple principle, which is termed tetrakinesis in application to function, tetraplasy in application to form. Thus, whereas inorganic transmutation may be twofold in its elaborate complexes of energy, organic transmutation is invariably fourfold in its elaborate complexes of energy.

Herein lies the first distinction between inorganic and organic evolution. The second distinction is that before life appeared, the inorganic physico-chemico-mechanical content of our planet was exactly the same. Not a single combination of energy and matter in the entire planet was capable of resisting shock, of repairing waste, of combating disintegration, of co-ordinated resistance; consequently, the structural history of the inorganic planet was one of alternate construction and destruction. The third distinction is that while the evolution of life advances by physical, chemical, and mechanical methods which we may more or less definitely measure and observe, this is only a half-truth, because living mechanisms differ from lifeless mechanisms, no matter how perfect, in being more or less self-adapting, self-repairing, self-perfecting, self-regenerating, self-modifying, self-resourceful, self-experimental, self-creative. It is observed that these self-adaptive powers lie solely in the internal potential energy of heredity, while they may be evoked as reactions to changing physico-chemical environment, to ontogenetic experience, to the changing biota of animal and plant life. Organs, tissues, and cells that have lost connexion with the heredity germ-plasm wear out exactly like other machines.

Consequently, the prefix *bio* is essential; in living things we are dealing with bio-physical, bio-chemical, bio-mechanical phenomena. Life has a bio-physico-chemico-mechanical basis.

The primary relation of these four bio-physical, bio-chemical, bio-mechanical actions and reactions, all involving energy, to Darwin's non-energetic principle of natural selection may be illustrated in the annual migration of the golden plover, *Charadrius dominicus*. Numbers of this species winter in Hawaii, where the oceanic climate is singularly uniform the year around, with no violent changes of season. The inborn impulse to northern migration is chiefly a bio-chemical process; the inborn sense of direction that guides the bird northward over two thousand miles of open ocean is chiefly a bio-physical process; the flight is bio-mechanical so far as the heart, the circulation of the blood, the bones, and the muscles are concerned, but bio-chemical in its energy supply. Under the severe struggle for existence all atypical plover probably drop into the sea, but under bio-mechanical self-adaptation every plover that completes the flight to the nesting-place is improved thereby, and in this process the whole race is annually standardised. This crucial, dominant bio-physical, bio-chemical, bio-mechanical period of flight transfers the bird into the breeding grounds, where new principles of natural selection prevail, especially in all the bio-chemical activities of the plover.

In this plover story we illustrate two fundamental principles of biology: first, as the primordial part of the process, the tetraplastic principle of the animal

<sup>1</sup> Address delivered before the National Academy of Sciences, Washington, on April 28.

<sup>2</sup> From E. B. Wilson's "The Physical Basis of Life" we quote a few lines embodying our idea of reaction: "No conception of modern biology offers a more accurate picture of the process of reaction than the words of Czapek, a chemist: 'The chemical reactions in the substance of this system . . . are not merely of one character, but of many. The converse probability is shaping itself that the production of any single character requires the co-operation of several or many units, possibly of all. . . . Every unit may affect the whole organism and all the units may affect each character. . . . The whole system may be involved in the production of every character.'"

mechanism developed by Osborn between 1893 and 1918, that all typical organisms depend upon the typical action, reaction, and interaction of the four complexes of energy, physical, chemical, mechanical. Secondly, (a) Darwin's selection principle whereby all organisms are constantly selected on their adaptive actions, reactions, and interactions; (b) subsidiary to this, the Osborn-Baldwin-Morgan principle (1896-1898) of "coincident selection," whereby through heritable potentialities of self-improvement, self-adaptation, etc., every race of organisms is not only standardised but also constantly improved; (c) the negative of Darwin's principle, the "cessation of selection" or panmixia of Weismann, whereby there is a gradual recession of unused or less used organs from a dominant to a subsidiary position in the life of the organism, finally to retention only in the germinal stage; (d) the internal bio-mechanism of selection, the "intra-selection" of Roux, whereby every element in the developing organism also has to contribute its quota or decline.

While intensive observation by palæontology of successive genetic phyla of organisms demonstrates that the chief selection principle of Darwin is con-

stantly operating in the rise and decline of all adaptive bio-mechanical organs, the subsidiary fortuitous selection hypothesis as originally conceived by Darwin leaves the greater part of the bio-mechanical evolution process entirely unaccounted for. While we palæontologists observe great currents of continuous bio-mechanical adaptation which are actually going on in the heredity germ-plasm, we find no evidence either of chance or of discontinuity in the whole domain of bio-mechanical evolution. The surface ripples of fortuity as observed in De Vriesian mutation and the occasional waves of heritage variation observed in botany, zoology, experimental embryology, and genetics do not blind us to the continuous adaptive bio-mechanical evolution of each organism, even to the minutest bio-mechanical detail in each organ.

This statement is borne out in a recapitulation of the chief bio-mechanical principles of adaptation formulated from the time of Aristotle and of Empedocles to the present time, five of which were first observed in zoology and confirmed in palæontology, the remaining four principles having been observed only in palæontology.

(To be continued)

### Periodicities and Predictions.

AN interesting paper by Prof. Axel F. Enström, Director of the Academy of Engineering Science, Stockholm, under the title "On Periodicities in Climatic and Economic Phenomena and their Co-variation," deals with the important question of extrapolating past climatic and economic data in order to predict future conditions. In his introduction the author claims that "an investigation along these lines of the coal prices and the general prices" published by him in 1913 has been justified by the prediction of an economic boom about 1918 and a depression with the bottom about 1922. But it is doubtful whether this success really affords a corroboration, for these events must have been mainly controlled by the termination of the War, and were forecasted by methods independent of such an upheaval.

It is rather surprising that the author "earnestly warns" his readers against the "absolutely unreliable" process of drawing a mean straight line through a graph of annual values and producing it; for the advantages and disadvantages of the method lie on the surface, and there are occasions when it may give useful information.

Prof. Enström points out that the ordinary plan of smoothing, say by 5 years, effects a bigger reduction in the amplitude of the shorter periods than it does in the longer: on the other hand, if we subtract each term of a series from the next the series of differences is free of secular change and the amplitudes of terms of short period grow by comparison with those of long period. So when he is examining the temperature of London in relation to a period of about 9 years, which he calls the  $\phi$  period, he smooths with respect to periods of 2, 3, 5, 11, and 13 years, and takes differences three times: and in order further to bring out the  $\phi$  component he subtracts from the resulting series that got by smoothing over 9 years; he then applies an elaborate correction (including a smoothing by 19 years) for the sake of the residual terms. As we should expect after so much selective treatment, the graph is strikingly cyclic, though there are irregularities; and the author's conclusion is that the  $\phi$  period is "not a homogeneous sine-wave of constant wave length but possibly a compound wave": there is, however, no comparison of the

amplitude with what would be given by a purely accidental set of data, and no Fourier analysis of the periods between 8 and 10 years. The question whether the period is compound is left unsolved.

In order to obtain a real basis for extrapolation in regard to the future, it seems clear that the series must be replaced by a number of harmonic terms, and extrapolation can only be made when it is shown that the series of harmonic terms gives a fair approximation to the original. The analysis of Prof. Enström appears rather complicated for the small amount of definite information that it provides regarding Fourier periods in the neighbourhood of 9 years.

A further departure is made in relation to "co-variation." After determining curves for the  $\phi$  periods of two quantities in the manner already described, the correlation coefficient between these curves is obtained: as might be expected from the inevitable similarity, high coefficients are derived when the data of one curve are advanced or retarded so as to produce coincidence of phase: and obviously it is misleading to speak of these results, got by a process that in general removes most of the character from the original curves, as if they were derived direct from the originals themselves. Thus it appears very unlikely that the variations of the yield of wheat in France are to any serious extent controlled by the length of the world's railways or control them; but by working out the  $\phi$  curves of these two quantities and moving the latter forward two years a coefficient of 0.82 is produced which Prof. Enström considers as "indicating a very high degree of correlation."

The working out of possible periods exercises great fascination on many minds, and trustworthy information regarding them is of decided value to science. But Beveridge's complete working out of the periodogram of wheat prices in western Europe led him to the conclusion that prophesying was not possible on the facts as he gave them; and Brunt's equally thorough investigation of Greenwich temperature led to a similar conclusion. Disappointment seems inevitable unless great care is exercised to avoid domination by periods is announced, and we hope that the insight and industry of Prof. Enström will find further scope in their elucidation.

## The Royal Observatory, Greenwich.

### ANNUAL VISITATION.

THERE was a departure this year from the usual routine on the occasion of the annual visitation of the Royal Observatory, Greenwich, on June 6, for the Board of Visitors met at Dorking and inspected the new magnetic station at Abinger, which has been completed during the year.

A large number of invited guests were, however, present at the Royal Observatory and inspected the instruments. The report of the Astronomer Royal was presented, dealing with the twelve months ended on May 10, 1925.

Fundamental observations have been continued as usual; the mean error of Brown's longitude of the moon in 1924 is  $-7.10''$ , practically identical with  $-7.12''$  in 1923. The altazimuth is being used for observation of fundamental stars in the prime vertical, the results are in close agreement with those of the transit circle, indicating a mean correction of  $+0.25''$  to Boss's Declinations between  $12^\circ$  and  $50^\circ$  N. The usual observations of variation of latitude were made with the Cookson floating zenith telescope. Application has been made to Cambridge Observatory for the renewal of the loan of this instrument for another seven years.

The 28-inch equatorial has been used for the measurement of 436 double stars, of which 37 were under  $0.5''$  separation. Dr. Steavenson observed Mars with this instrument last autumn; his drawings will be reproduced in the 1924 volume. 266 stellar parallaxes have now been determined with the Thompson 26-inch equatorial; details of all of them are ready for publication.

The 30-inch reflector is being used for the determination of stellar temperatures, using a prism crossed by a grating. Comparison is made with the positive crater of a carbon arc, which is mounted on the roof of the Octagon Room. The plates are measured in the micro-photometer; the results are stated to be encouraging. Four comets and two minor planets (including that of Baade) have also been observed visually and photographically. New plates are being taken with the astrographic equatorial for the determination of proper motions in the Greenwich Zone (Decl.  $64^\circ$  to  $90^\circ$ ). Between Decl.  $64^\circ$  and  $66^\circ$  there are 54 proper motions greater than  $20''$  a century (of which 29 are new), and 231 between  $10''$  and  $20''$ ; there are 18,194 stars in the zone.

There has been a considerable increase in sunspot activity; a spot in lat.  $16^\circ$  N. (on central meridian on May 6) was visible to the naked eye. Three papers dealing with the movements of spots and faculae in longitude and latitude, and the rotation period given by long-lived spots, have appeared in the Monthly Notices of the Royal Astronomical Society.

Magnetic observations are being taken in duplicate at Greenwich and Abinger to establish the relation between them. The values (at Greenwich) of Declension W., Horizontal Force, Vertical Force, and Dip for 1924 are  $13^\circ 22.8'$ ,  $0.18426$ ,  $0.43115$ , and  $66^\circ 51.7'$ ; the annual diminutions are  $11.5'$ ,  $0.00007$ ,  $0.00033$ , and  $0.5'$  respectively. The West Declension at Abinger is about  $12'$  greater than that at Greenwich; but this needs further investigation, as a defect was found in the Abinger instrument which has only recently been corrected.

The new standard sidereal clock, by Mr. W. H. Shortt, has been in use since January 1, and is very satisfactory; the master pendulum is in a vault under the Octagon Room, and the slave clock in the ordinary clock room.

Wireless time signals are received daily from Paris, Bordeaux, Annapolis, and Nauen. The first three are in the mean late on Greenwich by  $0.07$  sec.; Nauen is late by  $0.02$  sec.

The Astronomer Royal refers in his report to the astronomers who have visited the Observatory during the year. Prof. Lundmark and Mr. Asklof stayed for two months, studying photographic and parallax work; Mr. G. Merton is making a prolonged stay, being engaged chiefly in researches on cometary orbits. Several others paid short visits.

## University and Educational Intelligence.

BIRMINGHAM.—Dr W. N. Haworth, professor of organic chemistry in the University of Durham (Armstrong College, Newcastle-on-Tyne), has been appointed professor of chemistry, and director of the department of chemistry.

CAMBRIDGE.—Prof. A. C. Seward, Master of Downing College, has been re-elected Vice-Chancellor for the academic year 1925-6. Mr. H. Banister, St. John's College, has been appointed demonstrator in experimental psychology.

In connexion with the forthcoming meeting of the International Astronomical Union at Cambridge, it is proposed to confer the honorary degree of Doctor of Science upon the president of the Union, President W. W. Campbell, of the University of California; also upon Prof. W. De Sitter, of the University of Leyden; Prof. B. Baillaud, Director of the Observatory of Paris; Prof. H. Nagaoka, of the Imperial University, Tokyo; and Prof. F. Schlesinger, Director of Yale University Observatory.

At Trinity College the following appointments for 1925-6 have been made: Mr. Bertrand Russell to be Turner lecturer in the philosophy of the sciences, and Major-General Sir Frederick Maurice to be Lees Knowles lecturer in military science.

The Statutory Commissioners have notified the University that they propose to modify the recommendation of the Royal Commission with regard to the proposed House of Residents as follows: that if a Grace passed by this house involves a change of either statute or ordinance of the University, an appeal may be made to the Senate under certain conditions. If in the vote in the Senate—the body of graduate voters including residents and non-residents—there is a majority against the Grace, the Senate's vote shall stand good (and the Grace shall be rejected), if in this second vote the majority against the Grace is larger proportionately to all the votes cast than the majority of residents' votes cast on the second occasion is to the total vote cast by the residents. How this ingenious scheme, which restores the ultimate authority over statutes and ordinances to the whole Senate, will work out in practice, remains to be seen. It may be hoped that it will not often be brought into use.

Preliminary steps in the organisation of the proposed scheme of faculties are indicated by the Commissioners in a second memorandum on the subject of initial appointments under the scheme and the position of the present staffs of University and College lecturers. It is contemplated that the new scheme will come into force on October 1, 1926.

OXFORD.—On Tuesday, June 2, Convocation passed a decree conveying the thanks of the University to Dr. F. D. Drewitt, Christ Church, for his gift to the Hope Department of six volumes of the original water-colour drawings of lepidoptera made by William Jones of Calcutta, known as "Jones' Icones." Jones' drawings and descriptions are of high value to students of systematic entomology.

Under the auspices of the Vice-Chancellor, preparations have already begun for the visit of the British Association to Oxford in 1926. Local secretaries have been nominated, and a meeting has been summoned for the purpose of appointing a local general committee

DR. HAROLD A. WILSON, F.R.S., professor of natural philosophy in the University of Glasgow, has accepted reappointment to the professorship of physics which he held at the Rice Institute, Houston, Texas, from 1912 to 1924 inclusive.

RESEARCH in secondary education in America has been enormously stimulated since the War by the stream of pamphlets, leaflets, and magazines issuing from the Bureau of Education. At a conference of representatives of the National Society of College Teachers of Education and other interested bodies last March, a programme of co-operation was discussed and steps were taken towards the constitution of a National Committee to initiate, direct, and co-ordinate research. The Bureau of Education will act as a clearing-house for information on the subject

THE progress of educational research in the United States was extensively reviewed in the course of the proceedings of the education section of the American Association for the Advancement of Science at Washington last Christmas. A brief account is published in the February number of *School Life* of the scope of the papers—some forty or more—which were read on that occasion. The Americans are great experimenters, particularly in the very progressive private schools, in which the psychologist has a position and influence undreamed of in Great Britain. Among the more important of the large-scale experiments mentioned in the papers referred to is a progressive plan of grouping children by intelligence ratings that has been carried on in Detroit since 1920. In each of nine grades the children are divided into upper, middle, and lower groups, the upper and lower being each 20 per cent. of the whole. Basic courses of study and standards of promotion are worked out for each group, and special teaching methods are applied to the upper and lower groups. The scheme is reported to have worked well

A STATISTICAL survey of education, 1921-22, being advance sheets from the biennial survey, 1920-1922, has been issued by the United States Bureau of Education as Bulletin, 1924, No. 38. It gives a total school and college enrolment of 26 millions, with an estimated cost of 2000 million dollars. Enrolments in institutions under private management were as follows: kindergartens, 10 per cent. of the total; elementary, 6 per cent.; secondary, 9 per cent.; normal schools and teachers' colleges, 6 per cent.; universities, colleges, and professional schools, 60 per cent.; institutions of all kinds, 8 per cent. The estimated cost of the elementary schools is 1240 million dollars, of high schools 450 millions, and of universities and colleges 273 millions. The per capita costs of elementary and high school education were the same in private as in public schools, but the per capita cost of university education was 581 dollars in public and 364 dollars in private institutions. It is interesting to compare with these estimates the per capita cost of education in the universities and university colleges of Great Britain (excluding Oxford and Cambridge) according to the tables recently issued for 1923-24 by the University Grants Committee. Including part-time (14,245) and full-time (33,752) students, the cost per student is 74*l.* or, at the current rate of exchange, 354 dollars—almost exactly the same as in private universities in the United States.

## Early Science at Oxford.

JUNE 15, 1686. A letter from our President dated April ye 10th. was read; it gave an account that one Mrs. Hoden had several times before the death of divers of her relations *dreamed* of the losse of two or more of her teeth, having had noe such dreams at other times.

Then was read an observation communicated by Dr. Benbrig, concerning a gentleman who had a violent *paine* in his ear caused by maggots in it, a fly haveing blown in it the day before: Some milk being poured into his ear, at least sixty maggots came out, and the pain ceased.

Dr. Edward Tyson, Dr. Tankred Robinson, Francis Aston Esqr, Mr. John Flamstead, Mr. St George Ash of Dublin, and Mr. Christopher Pit of Wadham Coll. were elected members of the Philosophical Society.

JUNE 16, 1685. A discourse of Dr. Robinson's, and a Letter of Mr. Ray's, both concerning the French Marneuse, were read.

Mr. Pulleyn brought in an abstract of ye way of making artificiall Amber, extracted from a MS in Magdalen Hall Library, it is as followes—

### To make artificiall Amber.

Seeth Turpentine in an earthen pan well leaded, and put therein a little cotton, stirring it, untill it be as thick as paste, then pour it into what you will, and set it in the sun eight daies together, and it will be clear, and hard enough; you may make of this beads, hafts of knives &c: And when they are made so, set them to harden again in ye sun, and they will be very hard and clear.

A letter from Mr. Leigh giving a description and containing a draught of the Sepia, together with a paper written with ye naturall ink of that fish, was communicated. These things are sent up to ye Royal Society.

An accurate account with figures of a monstrous Cat dissected by Dr. Mullen of Dublin was communicated in a letter from Mr. Ash, Secretary of ye Dublin Society, for which ye Society ordered their thanks to both these gentlemen.

A description and draught of an artificiall Fountain by Dr. Papin, was presented from Mr. Aston.

JUNE 17, 1684. A letter from Mr. Aston, dated from London June ye 12th was read, a letter from Mr. Tancred Robinson, to Dr. M. L., concerning ye Bridg at Pont Esprit in France, was read. Dr. Plott affirms, that ye Bridg at Burton in Staffordshire (which is one of ye greatest in all England) is built after ye same manner with that at Pont St. Esprit: this occasion'd some discourse concerning ye running of Rivers; It was affirmed that Medway runns ye least way of any river in England, of that bigness.

Two remarkable cases relating to vision were communicated by Dr. Plot, to whom they were sent by Dr. Briggs of London; one of these cases was a *Nyctalopia*; a distemper not frequent amongst us.

It was affirmed, that Dr. Tu. Baker of Salisbury has (not long since) met with a disease of ye eye as yet undiscovered, it was a bag of matter on ye outside of ye ball of ye eye, prominent from ye *tunica adnata*; the Dr. cured his patient, and called this distemper *Bursa Oculi*

There being some Discourse concerning severall ways of makeing a *Spiritus fumans cum Aere*; it was ordered that a Spirit of that kind should be made, and an account of ye process brought into ye Society, which Mr. Bainbrigg undertook to do.

Dr. Pudsey, Fellow of Magdalen College, and Mr. Alexander Cuningham of St. Leonard's College in St. Andrews, were proposed to ye Society.

## Societies and Academies.

## LONDON.

**Geological Society**, April 22.—W. L. F. Nuttall. The stratigraphy and palæontology of the Laki series (Lower Eocene) of parts of Sind and Baluchistan (India). Some of the massive white foraminiferal Eocene limestones of Sind, with a thickness of about 600 feet, found along the Laki Range and in Lower Sind, contain a different and earlier fauna of Foraminifera than that of the Kirthar series as exposed in the Kirthar Range. In the area near Meting the following divisions in the Laki series are proposed: Laki Limestone, Meting Shales, Meting Limestone, Basal Laki Laterite. The term *Alveolina* Limestone is discarded, as *Alveolina* are found in both the Laki and the Meting Limestones. The Meting Limestone is correlated with the Dunghan Limestone of R. D. Oldham, which is found in the Bolan Pass and other places in Baluchistan. The Ghazij Shales of Baluchistan, which are absent in Sind, pass up conformably into the Lower Kirthar series. The upper part of these shales is younger than the Laki Limestone. In Sind the Laki Limestone is overlain unconformably by the Middle Kirthar, Nari (Oligocene), or Lower Manchar (Pliocene) beds. The Laki series rests unconformably on the Upper Ranikot, with the upper members of the Laki series as traced northwards overlapping the lower. The fauna of the Laki series, which is different from that of the Kirthar series, suggests that the former are of Lower Eocene age rather than Lower Lutetian, as has hitherto been supposed.

**Linnean Society**, May 7.—H. G. Cannon: The ectodermal origin of muscles in the crustacean, Chirocephalus. In the trunk region of a metanauplius of Chirocephalus the limbs appear at first as pouch-like outgrowths, the ectoderms between them forming a series of ridges projecting into the body-cavity. The inner edges of the ridges become nipped off from the more lateral ectoderm forming a string of cells containing deeply-staining fibrils. Later, dorsally and at the level of the inner face of the surrounding ectoderm cells, the fibrils lose their staining capacity and are replaced by a tendinous plate. Below this plate the fibrils divide into segments, converting the strings of cells into typical striped muscles. These muscles do not appear to correspond to the larval mesoderm of annelids.—Miss I. Andersson: The genetics of variegation and leaf-structure in ferns. Spores being sown on Knop-agar, the several kinds of prothallia could be counted and observed continuously. Segregation in respect of green or pale plastids may occur (1) at reduction, (2) during the prothallial growth, or (3) in somatic tissue of the sporophytes, or in any of these stages successively.—S. L. Moore: New species of *Compositæ* from Angola Land.

## DUBLIN.

**Royal Dublin Society**, April 28.—H. H. Poole: The photo-electric measurement of submarine illumination. A method is described of using photo-electric cells for submarine photometry which may be employed in a comparatively small vessel at sea in fine weather. The photo-electric current is passed through a known high resistance, the P.D. between the ends of the latter being balanced against a potentiometer. A telephone is used as a detector instead of a galvanometer, thus rendering a steady support unnecessary. This is effected by including a special form of inter-

rupter in the detector circuit of the potentiometer. This circuit also includes the primary of a two-valve amplifier, the output terminals of which are connected to the telephones. A vacuum photo-electric cell is used as a standard, the submarine illumination being measured by a cell of the Kunz type. The effects of obliquity of illumination and of reflection losses at the photometer window are specially considered. Preliminary tests have given satisfactory results.

**Royal Irish Academy**, May 11.—Miss A. L. Massy: An account of the Brachiopoda taken by the fishery cruiser *Helga* off the Irish coast, with a summary of previous Irish records. Eleven species are recorded, two from depths of more than 1000 fathoms, seven between 70 and 700 fathoms, and two from shallow water.

## EDINBURGH.

**Royal Society**, May 11.—F. A. E. Crew: Unilateral vasoligation on the senile male of the domestic fowl. Unilateral vasoligation in the fowl is not followed by rejuvenation phenomena. This suggests that the gonad of the bird is not endocrinologically equivalent to that of the mammal.—Miss Sheina M. Marshall: Plankton of the Firth of Clyde. Notes of the species occurring and their seasonal distribution.—Miss Frances M. Ballantyne: The continuity of the vertebral nervous system: Studies on *Lepidosiren paradoxa*. Numerous stages in the development of sensory nerve trunks (olfactory, auditory, spinal, lateral line), demonstrate that each trunk develops out of a protoplasmic bridge joining end organ and central nervous system at an early period of development while they are still in close proximity. The relations between neurofibrils and ganglion cells was dealt with and evidence adduced in support of the view that there is no real discontinuity at the so-called synapse.—E. B. Bailey: Perthshire tectonics: Loch Tummel, Blair Atholl, and Glen Shee. The stratigraphical sequence of the district shows only minor variations from that worked out by E. M. Anderson at Schiehallion, farther west (Quart. Journ. Geol. Soc., 1923). One of the main stratigraphical divisions, the Perthshire Quartzite Series, is disposed in three distinct recumbent fold-limbs of great cross-strike extent. Of these, the Cairnwell Limb is top, the Tummel Limb is middle, and the Ben y Cloe Limb is bottom. Important slides have been developed, more particularly in connexion with the Tummel Limb. Subsequent recumbent folding has greatly affected the Tummel Limb and digitations of the Cairnwell Limb.

## PARIS

**Academy of Sciences**, May 4.—The president announced the death of M. Albin Haller.—E. Goursat: Some partial differential equations of the theory of deformation of surfaces.—G. Bigourdan: The equations, of various origins, which may affect the pendulum corrections employed at the Bureau International de l'Heure (B.I.H.) during the five years 1920-1925. The corrections are affected by various errors due to different causes; five years' observations are discussed and an attempt is made to separate some of these causes of error.—Nicolas Kryloff: The estimation of the error made in the application of the method of W. Ritz for the approximate integration of differential equations.—N. Lusin: A problem of M. Émile Borel and the projective ensembles of M. Henri Lebesgue; analytical ensembles.—V. Romanovsky: The distribution of the mean square errors in observations on quantities

with normal distribution.—R. Dugas: The theory of fine structure and the principle of the equality of action and reaction.—L. Escande and M. Ricaud: The similitude of viscous fluids. Comparative experiments made with water and three oils of different viscosity. Reynolds's law held exactly, and the simultaneous application of the law of Reynolds and that of Reech showed that, giving to the homologous dimensions of two models a ratio equal to the ratio of the kinematic viscosity coefficients raised to the power  $2/3$ , similitude was realised.—Henri Abraham and René Planiol: Magnetic sesquioxide of iron. Ordinary ferric oxide (colcothar) is not ferromagnetic. If a non-magnetic ferric oxide is reduced at  $500^{\circ}\text{C}$ . in hydrogen or in carbon monoxide, the reaction stops at about the stage of magnetite. This finely divided magnetite is not pyrophoric but is readily oxidised. If heated in air it burns like tinder and gives a non-magnetic red oxide; but if heated in a current of air at  $200\text{--}250^{\circ}\text{C}$ ., oxidation is produced slowly and without incandescence. The resulting oxide is brown, has the same chemical composition as ordinary red ferric oxide, but is strongly ferromagnetic. Heated to  $700^{\circ}\text{C}$ . it is transformed into the non-magnetic red oxide.—Jean Jacques Trillat: Study of the fatty acids and the dicarboxylic acids by means of the X-rays. A slight alteration in technique, namely, dissolving the acid in alcohol, pouring some drops of the solution on a glass plate and allowing to evaporate, gives better results than the original method of pouring the melted acid on the plate. The thin layer behaves as a single crystal, and the X-ray spectrum shows only the fine lines corresponding to the length of the chain. Data are given for six fatty acids and four dibasic acids. The method can be applied in analysis, and will distinguish between a  $\text{C}_{17}$  acid and a mixture of  $\text{C}_{16}$  and  $\text{C}_{18}$  acids.—Salomon Rosenblum: A new determination of the ratio of the velocities of the two groups of  $\alpha$  rays emitted by the active deposit of thorium. The ratio of the velocities of the  $\alpha$  rays of thorium ( $\text{C}$  and  $\text{C}^1$ ) is found to be  $1.209$ , with a possible error of  $0.1$  per cent.—Th. De Donder: Affinity.—A. Boutaric and Mlle. G. Perreau: The quantitative study of the protection realised in a colloidal solution by the introduction of an electrolyte in a quantity too small to produce flocculation. Studies of colloidal suspensions of gamboge and sulphide of arsenic. The results are given in the form of curves.—Léon Guillet: The thermal treatment of certain nickel brasses.—Fred Viès and Mlle. Madeleine Gex: The ultra-violet absorption as a function of  $\text{P}_\alpha$  of some organic acids considered as ultra-violet indicators.—E. E. Blaise and Mlle. M. Montagne: The preparation of the acyclic  $\delta$ -diketones. By the condensation of ethyl magnesium bromide with the tetrathyldiamide of glutaric acid, the  $\delta$ -diketone dipropionylpropane has been shown in an earlier communication to be one of the reaction products. It is now shown that the diethylamide of  $\gamma$ -propionylbutyric acid and a ketone of the constitution  $\text{C}_2\text{H}_5\cdot\text{CO}\cdot(\text{CH}_2)_3\cdot\text{C}(\text{C}_2\text{H}_5)_2\cdot\text{N}(\text{C}_2\text{H}_5)_2$  are also produced in this reaction.—Lespieau and Charles Prevost: The hexabromide of diacetylene. The addition of bromine to diacetylene gives a hexabromide identical with that obtained by Noyes from the gas obtained by treating slightly oxidised copper acetylide with acid. From the hexabromide the diacetylene is easily regenerated by the action of zinc powder and alcohol.—Marcel Sommelet: The synthetic preparation of the homologues of benzyl chloride. The synthesis is based on the interaction of monochloromethyl ether and an aromatic hydrocarbon in the presence of stannic chloride as condensing

agent.—R. Lantz and A. Wahl: The 1-arylamino-2-naphthoquinones.—L. Cayeux: The relative age of the silex and dolomites in the chalk of the Paris basin.—Louis Besson: The pluvial capacity of the equatorial current. The periodic factor of climate.—E. Demoussy: The changes in concentration brought about by diffusion.—St. Jonesco: The combined action of hydrochloric acid and metallic sodium on the reddening of a flavone extracted from the red leaves of *Prunus pissardi*. The flavone, resembling quercetin in its behaviour to solvents, is attacked by metallic sodium, and the product of this reaction on treating with hydrochloric acid gives a red pigment. The latter does not appear to be a simple reduction product of the flavone, since other reducing agents do not produce the colouring matter.—Auguste Lumière and Henri Couturier: The anti-coagulating action of zinc salts. Sulphate of zinc, in a concentration of  $1$  in  $2000$ , completely prevents the coagulation of blood *in vitro*. Injection of the same salt into the living animal also has the effect of reducing the coagulability of the blood.—Mme. Randoin and E. Lelesz: Comparative variations of arterial glycaemia (effective and proteidic) and of the proportion of liver glycogen in the normal pigeon and in the pigeon submitted to a diet lacking in the water-soluble factor B. A deficiency of factor B does not prevent addition of the glycogen reserve nor does it prevent the sugar being set free in the blood, but the animal is deprived of a substance which is directly or indirectly indispensable to the combustion of the sugar.—P. H. Fischer: The rôle of the purple-producing gland of Murex and Purpura.—P. Cappe de Baillon: Double monsters in the phasmids.—L. Fage and R. Legendre: Swarms of *Scalibregma inflatum* observed while fishing with artificial light.

May 11.—Mlle. Madeleine Marquis, Pierre Urbain, and G. Urbain: The treatment of malacon. The separation of celium from zirconium. Solution is effected by treatment with sulphuric acid followed by potassium bisulphate fusion; the zirconium and celium are precipitated as double sulphate by addition of solid potassium sulphate. An account is given of various methods tried for the separation of these two elements. Fractional precipitation with saturated solutions of sodium carbonate has been found to give the best separation.—Gabriel Bertrand and M. Machebœuf: The presence of nickel and cobalt in animals. It has been shown that nickel and cobalt are widely distributed in arable earth and are also present in plants; nickel has now been proved to be present in animal tissues. In man and the higher animals the highest proportion of nickel is present in the liver. The amounts are extremely small, ranging from  $0.004$  milligram of nickel per kilogram of cow's milk to  $0.455$  milligram per kilogram in molluscs.—Paul Mentré: The projective properties of congruences, non  $W$ , with non-special complex linear osculator.—André Roussel: Semi-continuity and direct search for certain minima.—E. Henriot and E. Huguenard: The realisation of very high speeds of rotation. In the apparatus described the rotating body is not in contact with any liquid or solid and is free to take up its own axis of rotation. The rotor is supported and rotated by a current of compressed air; one model has maintained a constant velocity of  $4000$  turns per second for several hours.—P. Dumanois: The utilisation of anti-knocking compounds. A mixture of equal parts of petrol and kerosene with the addition of  $1.5$  parts per  $1000$  of lead tetraethyl gave good results in an internal combustion motor; there was no knocking, and the

consumption was the same as when pure petrol was used.—R. Forrer: An artificial magnetic anisotropy of nickel. The attainment of a state with a particularly simple cycle.—Josef Mikulas Mohr: The pole effect of the barium and neodymium lines in the visible part of the spectrum. The differences in wave-length due to the pole effect were studied in the interference spectrograph of Perot, one light bundle being taken from one of the poles and the other from the centre of the arc. The differences of wave-length negative pole minus centre and positive pole minus centre are given in tabular form for the chief lines of barium and neodymium.—Mme. J. S. Lattès: A method of analysis by absorption of radioactive radiations. A general method is developed capable of being applied to the analysis of any radiation, however complex.—J. d'Espine: The magnetic spectrum of  $\beta$  rays of great velocity of radium-B + C. Measurements are given for 13  $\beta$  rays of radium-B + C. The values of  $H_p$  are tabulated against the results of Ellis, Rutherford and Robinson, and Danysz, and are in good agreement with those of Ellis.—Louis Jacques Simon: Comparative chromic acid oxidation and molecular structure; tariric and stearolic derivatives.—Raymond Delaby and Georges Morel: The methylalkylglycerols. Notwithstanding the number of transformations involved, the best method of preparing the methylalkylglycerols is through the dibromhydrin, the stages being vinylalkylcarbinol, addition of bromine forming the dibromhydrin, conversion of the latter into the diacetin, from which the glycerol is obtained by the action of aqueous potassium carbonate.—Albert Baldit: Magnetic measurements in the centre and east of France.—Ernest Esclançon: Zones of silence by reflection on the surfaces of atmospheric discontinuities.—Barré and Schnell: The propagation of sound waves in the soil. Two velocities for sound in the soil were found: 2000 and 8500 metres per second. The higher velocity was found by observers on granite, the mine being also buried in contact with rock, whilst in experiments giving a velocity of 2000 metres the observer and the mine were both on sand.—René Souèges: The embryogeny of the Lythraceæ. The development of the embryo in *Lythrum Salicaria*.—C. Charaux: Datiscline, the glucoside of *Datisca cannabina*. Datiscline has the formula  $C_{27}H_{30}O_{15}$ , and crystallises with four molecules of water. Hydrolysed with acids, it gives equal molecules of datiscetine, glucose, and rhamnose, but on hydrolysis with a ferment it gives datiscetine and rutinose.—Marc Bridel: Primeverose, primeverosides, and primeverosidase.—Raymond Hamet: The medullary cribro-vascular formations of two Crassulaceæ.—Lucien Daniel: New researches on heredity in the grafted Jerusalem artichoke.—A. Maige: Various methods of appreciation of the limiting level of amylogenous condensation.—A. Němec and K. Kvapil: The presence of nitrates in forest soils. Determinations of nitrate in soils of various ages under fir, pine, beech, oak, ash, and hornbeam.—F. Couturier and S. Perraud: Some properties of urea in contact with soils.—Adrien Auguet and Albert Bruno: The persistence of dicyandiamide nitrogen in a moulded calcium cyanamide, after remaining several months in the soil.—H. Labbé and B. Théodoresco: The action of insulin on the nitrogen metabolism. In a normal dog, injections of insulin are followed by an increase in the amounts of nitrogen excreted; the effect often persists several days after the injection.—Armand Dehorne: Observations on the biology of *Nereis diversicolor*.—Goris and M. Metin: The alteration of solutions of aconitine on keeping. On keeping aqueous solutions of aconitine nitrate there is a

steady loss of toxicity; the decrease is very regular, and is proportional to the time.

## CALCUTTA.

Asiatic Society of Bengal, April 1.—Hem Chandra Das-Gupta: On the occurrence of *Scylla Serrata* Forskal in the upper Tertiary beds of Hathab, Bhavanagar (Kathiawar). Fossilised specimens of the common edible crab of India have been known since 1767, but precise data regarding the locality and the age of the beds have been wanting. The sternal portion of such a fossil crab obtained from Hathab, Bhavanagar State, has been found in Miocene beds.—Kalipada Biswas: Sub-aerial Algæ of Berkuda Island. The Algæ occurred on the soil, on roofs, and on walls. Nine species are described, of which four are reported for the first time from India, and one—*Gomphospharia apontina*, var. *muralis*—Biswas—is a new variety.—D. Majumder: Some characteristics of Kolarian songs. The songs are classed under four groups: (1) General; (2) love-songs; (3) moral songs, addressed to boys or girls; (4) miscellaneous (domestic affairs, food, etc.).—D. Majumder: On the terminology of relationship of the Hos of Kolhan. There are mainly two systems of kinship terms. One is applied to groups, the other to individuals. The latter system is of rare occurrence.—Braja Lal Mukherjee: The word "vrā" in the Rig Veda. The word "vrā" means hunter, and does not mean troop or host.—J. J. Modi: A note on the custom of the interchange of dress between males and females.

## VIENNA.

Academy of Sciences, March 12.—A. F. Sonnenschein: The homing of feelerless bees; a contribution to the sense of orientation in the honey-bee. Bees whose antennæ have been amputated find their hive and its entrance in much the same way as normal bees; the sense of smell does not seem essential for their return home.—M. Kohn and S. Grun: Bromo- and bromo-nitro-ether of pyrogallol (xii.). Communication on bromo-phenols.—M. Kohn and M. Heller: On the interchangeability of halogen atoms and of nitro groups in some nitro-halogen-phenol-ethers (xiii.). Communication on bromo-phenols.—M. Kohn and A. Rosenfeld: (1) New observations on halogen phenols (xiv.). Communication on bromo-phenols. (2) A contribution to the knowledge of the pseudo-phenols (xv.). Communication on bromo-phenols.—J. Weissenberger, F. Schuster, and R. Henke: On the molecular compounds of the phenols, the localisation of the field of force of the residual valency. On organic molecular compounds, the group  $CCl_3$ .

March 19.—R. Schumann: A contribution to the subterranean tectonic of the Vienna basin.—E. Heinricher: Cattle-grazing, a factor contributing to change of form and formation of species in plants. *Centaurea jacea*, var. *pygmæa*, an example.—K. Horovitz and J. Zimmermann: Investigations on the exchange of ions in glasses.—J. Zimmermann and J. Schneider: Characters of glasses in terms of their electromotive properties.—J. Schaffer: On extensible elastic sinews in skeletal muscles. The limits of elasticity are considered, also the case of a Paraguayan marsupial which hangs for hours by its tail from branches.—H. Handel-Mazzetti: New Chinese plants (xxxiii.).—The late G. von Niessl: Catalogue of data for determining the paths of 611 great meteors.—A. Aigner: The formation of valleys on the southern edge of the Lower Tauern.—A. Friedrich and J. Diwald: On the lignin of pine-wood.

## Official Publications Received.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 20, Part 14: The American Species of *Canavalia* and *Wrightia*. By C. V. Piper. Pp. viii+555-588. (Washington: Government Printing Office. 10 cents.)

Royal Botanic Gardens, Kew. Orchids (*Orchidaceae*), Set 3. 6 post cards in colour with descriptive folder. (Kew: Royal Botanic Gardens.) 1s.

Proceedings of the Royal Society of Edinburgh. Session 1924-1925. Vol. 45, Part 1, No. 11: The Modes of Vibration of a Stretched Membrane with a particular Law of Density. By Dr. E. L. Ince. Pp. 102-116. 1s. 6d. Vol. 45, Part 1, No. 12: A Survey of Clyde Plankton. By Sheila M. Marshall. Pp. 117-141. 2s. Vol. 45, Part 1, No. 13: The Relation of Sea-Growth and Spawning Frequency in *Salmo salar*. By W. L. Calderwood. Pp. 142-148. 9d. Vol. 45, Part 1, No. 14: The Minimum System of Two Quadratic Forms. By Prof. H. W. Turnbull and J. Williamson. Pp. 149-165. 1s. 6d. Vol. 45, Part 1, No. 15: The Law of Blackening of the Photographic Plate at Low Densities. By E. A. Baker. Pp. 166-186. 2s. Vol. 45, Part 1, No. 16: The Theory of Continued Determinants from 1900 to 1920. By Sir Thomas Muir. Pp. 187-224. 6d. Vol. 45, Part 2, No. 17: Discontinuities in the Atmosphere. By A. H. R. Goldie. Pp. 213-229+4 plates. 2s. 6d. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. Studies concerning the Pollination, Fertilization and Breeding of Red Clover. By R. D. Williams. (Series H, No. 4, Sessions 1921-24.) Pp. 58. (Aberystwyth.) 3s. 6d.

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Department of Commercial Intelligence and Statistics, India. Agricultural Statistics of India, 1922-23. Vol. 1. Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, and Land Revenue Assessment, and Harvest Prices in British India. Pp. ix+81+10 plates. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1s. 4d.

Bulletin of the National Research Council. Vol. 10, Part 2, No. 52: Honors Courses in American Colleges and Universities. By Frank Aydelotte. Second edition, revised. Pp. 96. (Washington, D.C.: National Academy of Sciences.) 1 dollar.

Safety in Mines Research Board. Paper No. 7: Second Report of the Explosives in Mines Research Committee, 1924. Pp. 10. (London: H.M. Stationery Office.) 3d. net.

Medical Research Council. Fifth Annual Report of the Industrial Fatigue Research Board to 31st December 1924 (including previous Contributions from Investigators). Pp. 76. (London: H.M. Stationery Office.) 1s. 9d. net.

Leeds University: Department of Pathology and Bacteriology. Annual Report. By Prof. Matthew J. Stewart and Prof. J. W. McLeod. Pp. 15 (Leeds.)

Bulletin of the American Museum of Natural History. Vol. 52, Art. 1: Scientific Results of the Expedition to the Gulf of California in charge of C. H. Townsend by the U.S. Fisheries Service, *Albatross* in 1911. 14: Description of the *Albatross* Lower California Expedition. By Charles H. Townsend and John T. Nichols. Pp. 20+4 plates. (New York.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 6, 1924. 1: Månadsoversikt av vädret och vattentillgång jämte anstalts årsberättelse. Pp. 101. (Stockholm.) 250 kr.

Recueil des travaux chimiques des Pays-Bas. Publié par la Société Chimique Néerlandaise. Tome 44 (4e Série, T. 6), No. 5, Mai. Numéro consacré au professeur Bohuslav Brauner, publié par ses amis et élèves en commémoration de son 70e anniversaire, 1855-8 Mai-1925. Pp. 281-628. (Amsterdam. S. A. d'Éditions scientifiques D. B. Centen.)

Aeronautical Research Committee. Reports and Memoranda, No. 949 (Ae. 169): The Performance of Tandem Systems. By H. Glauert. (Ae. 3, a Aerofoils, general, 118-T. 1777.) Pp. 11+4 plates. 6d. net. Reports and Memoranda, No. 953 (Ae. 172): Experiments to verify the Hypothesis of the Elements of an Airscrew Blade. By C. N. H. Lock. 11: Report of H. C. H. Townsend. (Ae. 3, d. Airscrews 75-T. 1978.) Pp. 4+4 plates. 4d. net. (London: H.M. Stationery Office.)

Instituut voor de Landbouw. "s Lands Plantentuin." Treubia: recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 6, livraison 2, février. Pp. 93-220. (Batavia.) 2.50 f.

Department of the Interior: United States Geological Survey. Bulletin 755: Mineral Resources of Alaska; Report on Progress of Investigations in 1922. By A. H. Brooks and others. Pp. ii+22+xxv+12 plates. 40 cents. Bulletin 764: Phosphate Deposits in the Wind River Mountains, near Lander, Wyoming. By D. Dale Condit. Pp. v+29+3 plates. 15 cents. Bulletin 770: The Data of Geochemistry. By Frank W. Clark. Fifth edition. Pp. 841. 1 dollar. (Washington: Government Printing Office.)

## Diary of Societies.

SATURDAY, JUNE 13.

MINING INSTITUTE OF SCOTLAND (at St. Margaret's Hall, Dunfermline), at 8.30.—General Meeting.

PHYSIOLOGICAL SOCIETY (at Manchester).

MONDAY, JUNE 15.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. Alfred T. Schofield: The Capture of the Unconscious (Annual Address).

ROYAL SOCIETY OF MEDICINE, at 9.30.—Dr. F. Buzzard: Charcot and the Centenary Celebration of his Birth.

NO. 2902, VOL. 115]

TUESDAY, JUNE 16.

INSTITUTION OF MINING ENGINEERS (at South Wales Institute of Engineers, Cardiff), at 11 A.M.—Sir John Cadman: Petroleum Refining in South Wales.—Dr. J. S. Haldane: The Maximum Efficiency of Heat Engines and the Future of Coal and Steam as Motive Agents.—The Shutting Off of Gob-Fires in Gassy Seams (Memorandum by the Gob-Fires Committee of the Institution).—J. I. Graham and Dr. T. D. Jones: Spontaneous Combustion in the South Wales Coalfield.—J. H. Cockburn: The Principles and Operation of the Mines (Working Facilities and Support) Act, 1923, Part I.

ROYAL INSTITUTION OF GREAT BRITAIN (jointly with Chemical Society, Society of Chemical Industry, and Association of British Chemical Manufacturers) (at Royal Institution), at 11 A.M.—Celebration of the Discovery by Michael Faraday of Benzene.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. A. K. Wilson: Disorders of Motility and of Muscle Tone, with special reference to the Corpus Striatum (Croonian Lectures) (III).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—G. F. Shirras: Income Tax and the Burden of Taxation and Public Debt.

MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—Dr. A. Hutchinson: (a) The Use of Alignment Charts in Crystallography. (b) The Use of the Stereographic Projector for the Interpretation of Laue Crystal Photographs.—H. E. Buckley and W. S. V. Van der Linde: Crystal-structures of the Sulphides of Mercury.—Dr. E. Spencer: Albite and other Authigenic Minerals in Limestone from Bengal.—Dr. R. Campbell and J. W. Lunn: Chlorophyll and the Dolomites (Tholeites) of Dalmahoy and Kames in the Scottish Highlands.—Dr. L. J. Spencer: Tenth List of New Minerals with an Index of Authors.

WEDNESDAY, JUNE 17.

ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 4.30.—Mrs. S. Stevenson: The Dheds.

ROYAL METEOROLOGICAL SOCIETY, at 5.—J. E. Clark, I. D. Margary, and R. Marshall: Report on the Phenological Observations in the British Isles from December 1923 to November 1924.—J. N. Harrison and Dr. G. M. B. Dobson: Measurements of the Amount of Ozone in the Upper Atmosphere.—J. Baxendell: Meteorological Periodicities of the Order of a Few Years, and their Local Investigation; with Special Reference to the Term of 5-1 years in Britain.

SOCIETY OF GLASS TECHNOLOGY (at Sheffield).

THURSDAY, JUNE 18.

ROYAL SOCIETY, at 4.30.—Lord Rayleigh: Luminous Vapour from the Mercury Arc and the Progressive Changes in its Spectrum.—Prof. J. C. McLennan and A. B. McEay: On the Series Spectrum of Gold.—Prof. W. A. Bone, D. M. Newitt, and D. T. A. Townend: Gaseous Combustion at High Pressures, Part V.—W. T. David: The Effect of Infra-Red Radiation upon the Rate of Combustion of Inflammable Gaseous Mixtures.—R. K. Schofield and Dr. E. K. Rideal: The Kinetic Theory of Surface Films.—To be read in title only.—Prof. H. M. Macdonald: The Condition that the Ratio of the Intensities of the Transmitted and Reflected Electric Waves at the Interface between two Media is independent of their Plane of Polarisation.—Prof. C. V. Raman and L. A. Ramdas: The Scattering of Light by Liquid Boundaries and its Relation to Surface-Tension. Parts I. and II.—H. Weiss: The Application of X-rays to the Study of Alloys.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Hon. W. G. A. Ormsby-Gore: Some African Problems.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. A. K. Wilson: Disorders of Motility and of Muscle Tone, with special reference to the Corpus Striatum (Croonian Lectures) (IV).

CHEMICAL SOCIETY, at 8.—H. Phillips: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XXVII. Some Esters of *p*-toluene Sulphonic Acid. By F. R. Goss and Dr. C. K. Ingold: The Chemistry of Nitrogenous Compounds. Part I. The Conversion of Cycloids into Ketones.—F. H. McDowall: Constituents of *Myoporum laetum* Forst. ("The Ngao"). Part I.—J. Kalif and R. Robinson: A Synthesis of Datisetin.—J. Allan, A. E. Oxford, R. Robinson, and J. C. Smith: The Relative Directive Powers of Groups of the Forms RO- and RRN- in Aromatic Substitutions. Part IV. A Discussion of the Observations recorded in Parts I, II, and III.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Annual General Meeting) (at 11 Chandos Street, W.1.), at 8.15.—Induction of Dr. A. Balfour as President.—Dr. G. C. Low: The Use of a Drug named "Smalarina" in the Treatment of Malaria.—Award of the Chalmers Medal to Prof. Warrington Yorke, who will read a paper on Further Observations on Malaria made during Treatment of General Paralysis.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY—Summer Meeting in the Gloucester District (continued on June 19, 20).

SATURDAY, JUNE 20.

ASSOCIATION OF WOMEN SCIENCE TEACHERS (Summer Meeting) (at Birmingham University), at 10.45.—Business Meeting.—At 11.30.—Dr. Shakespear: Colour (Lecture).

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section) (in Bio-chemical Laboratory, Cambridge), at 2.30.—Dr. Kay and Dr. Vines: Bone Metabolism in Rickets.—At 4.45.—Dr. J. F. Gaskell: The Relationship of Experimental Pneumonia in Rabbits to the Pneumonias of Childhood.

FREE PUBLIC LECTURE.

THURSDAY, JUNE 18.

St. Mary's Hospital (Institute of Pathology and Research), at 5.—Dr. R. Robison: The Chemistry of the Calcification of Bone.



SATURDAY, JUNE 20, 1925.

## CONTENTS.

	PAGE
The Amani Research Institute	933
The Protection of Wild Birds. By A. L. T.	934
Egyptian Mathematics—II. By Prof. D'Arcy W. Thompson, C.B., F.R.S.	935
Physiology for Zoologists	938
Yorkshire. By G. W. Lamplugh, F.R.S.	939
The Falkland Islands	940
Our Bookshelf	940
Letters to the Editor:	
The Coherence of Superposed X-Radiations.—Prof. C. G. Barkla, F.R.S., and Gladys I. Mackenzie	942
Radio Transmission round the Earth.—T. L. Eckersley	942
Spiral Springs of Quartz.—Dr. K. Šliupas; C. V. Boys, F.R.S.	943
Bioluminescence.—Dr. James Weir French	944
Dosage with Ultra-Violet Radiation.—Dr. H. D. H. Drane	945
The $K$ -Absorption Levels of the Light Atoms: A Correction.—Dr. H. Robinson	945
Anomalous Dispersion and Multiplet Lines in Spectra.—Prof. C. V. Raman, F.R.S., and S. K. Datta	946
A New Standard Solution for Sahli's Hæmometer.—A. K. J. Koumans	946
Approximations to the Probability Integral.—W. J. Luyten	947
The Word "Australopithecus" and Others.—Dr. F. A. Bather, F.R.S.	947
A New Locality for Jurassic Insects.—Prof. T. D. A. Cockerell	947
Mercury Helide: A Correction.—J. J. Manley	947
Quantum Radiation.—Prof. Alfred Lodge	947
A New Determination of the Distribution of Stars with respect to Magnitude and Galactic Latitude. By Frederick H. Seares and Prof. P. J. van Rhijn	948
The Expedition of the R.R.S. <i>Discovery</i>	950
Obituary:	
M. Camille Flammarion. By William Porthouse	951
Current Topics and Events	953
Our Astronomical Column	957
Research Items	958
The Origin of Species as revealed by Vertebrate Palæontology. By Dr. Henry Fairfield Osborn	961
Accuracy of Weighing in the Eighth Century. By E. J. H.	963
University and Educational Intelligence	964
Early Science at Oxford	965
Societies and Academies	965
Official Publications Received	968
Diary of Societies	968

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NO. 2903, VOL. 115]

## The Amani Research Institute.

THE announcement made in the House of Commons on June 10 by the Hon. W. Ormsby-Gore, Under-Secretary of State for the Colonies, that early steps are to be taken for the establishment of the Amani Institute in Tanganyika Territory and for its upkeep as a centre of scientific agricultural research for the benefit, first, of the British East African dependencies, and secondly, of tropical economic development generally, is a very welcome one, for which we have long been waiting.

The Amani Institute was founded by Germany in 1902. The Institute is situated in the Eastern Usumbara Mountains, about thirty miles from the port of Tanga, and is approached by railway as far as Sigi or by a good motor road. The main buildings, including the laboratories and most of the residences, are situated in a group at a height of about 3000 feet. The Institute grounds comprise some 600 acres, 200 acres of which are under cultivation and the rest are virgin forest. As the mean annual temperature at Amani is 67·8° F. and the average rainfall is 55 inches, the climate is very pleasant; it is a healthy place and very free from mosquitoes. The buildings consist of several residences and very good and well-fitted chemical, botanical and zoological laboratories, together with a herbarium and library and the various garden buildings. A full description of the Institute has been given in the *Berichte über Land- und Forstwirtschaft*, Band II., and in the *Jahresbericht des Biologischen Landwirtschaftlichen Instituts Amani* for the year ending March 1914. These records, with their accompanying plans, show that the Institute was designed on a scale more nearly appropriate to the needs of a territory, such as that it was intended to serve, than anything provided by the Government of a British Crown Colony.

The work carried out by the Institute while in German hands was of a very valuable character, for there was developed an admirable scientific establishment devoted to the intensive study of the problems connected with vegetable physiology, both on the nutritive and the genetic side, on the fungal and insect aspects of plant pathology, and also with regard to the chemistry of soils and of plants.

In establishing the Institute at Amani, Germany had created a research station comparable to the corresponding Institute at Pusa in India, to which India owes so much, and to the Institute at Buitenzorg in Java, which has so long served the Dutch East Indies as a central station for the study of the many problems in tropical agriculture in the East. Amani during its period of activity under German management showed that it was a worthy rival both of Pusa and Buitenzorg, and, had it been allowed to continue as it was begun, it would no doubt have been able to confer

benefits on eastern tropical Africa as great as those which already stand to the credit of the Indian and Javan establishments.

Ever since the Tanganyika Territory came into British hands, however, the Amani Institute has been in a very uncared-for condition. For the first few years a director was in charge of the establishment, but as he had no officers working under him his duties were rather those of a caretaker than a director, and it was not possible for scientific work of any value to be done there at all, especially as he had to see to the proper care of the valuable instruments, books and specimens in the laboratories. In addition to the Director there has been a head gardener or Curator, who has been responsible for the plantations and for all the gardening work. These two officers have been in sole charge of the Institute. Since the retirement of the Director, the Curator has been the only European at Amani; and it is satisfactory to know that he has maintained the Institute and the grounds, and has been given the necessary help to look after the herbarium collections.

Amani properly constituted would serve not only as a centre for research, but also would be a valuable place to which the scientific workers attached to the Departments of Agriculture could go in connexion with the various problems confronting them in the several departments, while research officers at Amani would be engaged in working out the problems brought to their notice by the agricultural officers throughout these Colonies.

Another point of great value in such a place as Amani would be that scientific workers from home and from other parts of the Empire would be able to work at the Institute on scientific problems, as was the case in the past, and in the same way that botanists and other scientific officers are now able to carry out their researches at Pusa or Buitenzorg.

The matter of the re-establishment of Amani has, we believe, been under consideration at the Colonial Office for some years, and it seems unfortunate that instead of taking direct action from home, the various Colonies have been consulted as to whether or not they considered Amani would be of any value to them. Amani should be essentially an Imperial rather than a local institution, and it should be so maintained and extended as to serve as an agricultural research institute for the conjoint benefit of all the British Colonies and Protectorates in East Africa. In order that the Institute should fulfil its functions in the best possible manner, it should be independent of the control of any Department of Agriculture in these Colonies and Protectorates.

The potential value of Amani to the East African dependencies is immense, and it is essential that the Institute should be placed on a proper basis with as little delay as possible.

## The Protection of Wild Birds.

TWO years ago Viscount Grey of Fallodon introduced a Bill on this subject in the House of Lords, as was noticed in these pages at the time, but the measure did not succeed in becoming law before the dissolution. In the present Parliament a Bill has been introduced by the Home Secretary and at present awaits a second reading in the House of Commons. The new Bill closely resembles its predecessor, although the drafting and arrangement have been improved, and it likewise aims at giving effect to recommendations of the Departmental Committee which reported in 1919. It is intended to supersede all the existing legislation on its particular aspect of the subject, apart from the special Game Laws, and to secure uniformity, simplification, and greater effectiveness.

The Bill gives some general protection to all birds by the total prohibition of certain methods of destruction and capture involving obvious cruelty. Bird-catching is to be strictly regulated, and prohibited on Sundays throughout the year, and on highways and commons at all times. In addition, special protection is given to different species according to three categories into which all birds are for this purpose to be divided. Birds named in the first category, with their nests and eggs, are to be protected absolutely at all times. Birds named in the second category, with their nests and eggs, are to be protected absolutely during the close season. The third category comprises all other species; these, but not their nests and eggs, are to be protected during the close season except against the owner or occupier of the land and his agents. (The protection of nests is a useful innovation.) The general close season is from March 1 to August 11. The woodcock has a special close season from February 1 to August 31, and the nests and eggs of the lapwing are not protected against the owners and occupiers of the land before April 15.

The Home Secretary, and in Scotland the Secretary for Scotland, is to have power to vary the classification or the close season of any bird, either generally or locally. In particular, he has power to give the status of Category I. to all birds in any bird sanctuary; but he may make exceptions, which is a wise provision in view of the fact that the undue multiplication of a common aggressive species may be at the expense of the others which it is desired to protect. He may also grant exempting licences for scientific purposes. This is a useful provision, but care will be needed to discriminate between genuine investigators and the type of collector, especially of eggs, who levies special toll on rare species and does nothing to increase ornithological knowledge.

Permits are also to be necessary before any imported foreign bird may be released in Great Britain. The case of the little-owl has taught its lesson, for this alien has become a pest and a menace to other birds in some parts, and has also tended to discredit the native owls, which have in reality quite different habits. In the exercise of these various powers the Home Secretary and the Secretary for Scotland are to be aided by advisory committees. These bodies are already in existence, for their institution was a recommendation of the Departmental Committee which had not to await legislation.

The new Bill will introduce a welcome uniformity which is lacking under the present system whereby too much is left to the initiative of local authorities. In addition to administrative considerations, the migratory habits of very many species make it impossible to deal logically or effectively with questions of protection from a local point of view. Variations between one district and another have also brought the law into disrepute from its very complexity. In other ways, too, the new Bill is less cumbersome to administer and is simpler to understand.

Apart from simplification, the new Bill should be more effective than the present law. It increases penalties and the powers of the police. It also makes it easier to prove an offence. The onus is put on any person found in possession of illegally taken birds or eggs, and taxidermists are to keep registers of all specimens coming within the scope of Categories I. and II. Similarly, it will no longer be possible to expose "plover's" eggs for sale more than five days after the beginning of protection: an absurd anomaly will thereby be removed.

The new Bill is therefore greatly to be welcomed, and one may hope that with its official backing it may indeed come into operation on the date proposed, January 1, 1926. It may perhaps be criticised, however, on the ground that it does not go far enough. It is mainly uncommon birds that are listed in Categories I. and II., and there is not full protection for some of the common insectivorous species—for example, the swallow—which are universally admitted to be beneficial as well as beautiful. It may be answered that the law as a whole gains by avoiding the creation of too many offences, and in any event there will be power to add to the schedules without the difficulty of a fresh appeal to Parliament. The point may have importance when the question of international co-operation as regards migratory species again comes forward, as there is ground for hoping it will at an early date.

There are two general provisions which one misses from the Bill, although both were recommended by the Departmental Committee. It was proposed that

the advisory committees were to conduct investigations into the economic status of various species, something corresponding to the Hungarian Institute of Ornithology or the U.S. Bureau of Biological Survey being contemplated; at present, it does not appear that the committees are to be given the necessary machinery for performing this function, and they are defined as being purely advisory. The Departmental Committee also stressed the necessity for providing watchers for bird sanctuaries, because an unguarded sanctuary becomes the obvious prey of collectors and pot-hunters and is therefore worse than useless. The cost of watchers at a few selected places would be trifling to the central or local authorities, but it is nevertheless a heavy burden upon the available voluntary sources of funds for this national work.

A. L. T.

### Egyptian Mathematics.<sup>1</sup>

*The Rhind Mathematical Papyrus: British Museum 10057 and 10058.* Introduction, Transcription, Translation, and Commentary by Prof. T. Eric Peet. Pp. iv + 136 + 24 plates. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1923.) 63s. net.

#### II.

**A**MONG the mathematical processes known to the Egyptians (for some few of which we have to go to the Berlin and Moscow papyri) were squaring and extraction of square roots, arithmetical progressions and simple geometrical progressions starting from unity, the solution of equations of the first degree, and a few simple cases of equations of the second degree. In geometry, or rather mensuration, they thoroughly understood the areas of square and rectangle; they knew pretty well how to deal with triangles, though precisely how much they knew is a more debatable matter; in a problem dealing with the truncated (isosceles) triangle, we recognise Hero's *τραπέζιον ἰσοσκελές*. They found the area of the circle by squaring  $\frac{8}{9}$  of its diameter, a near approximation—giving  $\pi = 3.160$ . . . . They knew the volume of the cube and rectangular parallelepipedon; they found the volume of a cylinder by multiplying its height into the area of its base; and one remarkable problem in the Moscow papyrus gives a correct solution for the frustum of a regular square pyramid. Their elaborate system of weights and measures Griffiths especially, and other writers, have sufficiently explained.

Towards the close of his admirable introductory chapter, Prof. Peet gives us a short but very interesting

<sup>1</sup> Continued from p. 902.

comparison between Egyptian mathematics and that of the pre-Semitic or Sumerian Babylonians. We know little or nothing of how this latter people worked their problems, for what they have left us consists of bare tables of multiplication and division, of squares, and of square and cube roots. But they were undoubtedly versed in elaborate calculations, and two points in their mathematical system stand out as of the highest interest. In the first place they used a sexagesimal notation, in which lie the roots of many things, including the division of the hour into 60 minutes, and of the circle into 360 degrees (apparently a "smoothing" of the 365 days of the year); Euler was using a pure Sumerian notation when he went on from minutes and seconds to tierces (just as Ptolemy did), and even to quarts, quints and sexts. The curious question arises whether this sexagesimal system was primitive, or was deliberately adopted for its convenience; and Prof. Peet, leaning to the latter view, shows that 10 remained a subordinate unit, and that even the numbers from six to ten are but derivatives of those from one to five. The second point, marking a very high grade of mathematical insight, was the use of a "positional notation," closely comparable to that which we ourselves inherit from the Moors. Thus, just as we understand, when we write 365, that the 3 has to be multiplied by  $10^2$ , etc., so the Sumerian could write 32.12.43, and mean or assume that the 32 was multiplied by  $60^2$ , and the 12 by 60; the whole number was expressed as elegantly in his notation as we express it by 115,963. The singular thing, however, is the apparent mixing up here of a decimal with the sexagesimal system; for the 32 was, literally, thirty-two, *i.e.* it was expressed by three tens and two units: the fact being that their notation had only two signs, a unit and a ten, and was in this respect no more advanced than the Egyptian.

Prof. Peet's short comparative sketch of Sumerian arithmetic contains many other curious things, into which we cannot follow him; it is a subject which becomes more interesting the more we know of it. On one of its by-paths we have Hilprecht's attempt to demonstrate that Plato's mystical "Number" has its roots in the old sexagesimal system, deep down in Sumerian arithmetic; it may fall short of convincing, as Prof. Peet declares, but it is very interesting indeed. The classical student may thank Prof. Peet for his short but excellent epitome of what Herodotus, Strabo, Diodorus, and a few other Greeks have to say regarding Egyptian mathematics. *Inter alia*, he comes to the conclusion that the famous *harpedonaptae*, or rope-stretchers, were no more than land-measurers; in other words, that they used their rope just as our surveyors use their "chain."

We need not try to epitomise the range of problems which the Rhind papyrus contains, much less to summarise the indispensable comments and explanations which Prof. Peet gives. But it may whet the student's appetite, and send him all the quicker to the book itself, if we quote as briefly as possible one or two actual problems. Let us begin with one of the problems of "division of loaves," which are merely simple exercises in the use of fractions. "To divide nine loaves among ten men. You are to multiply  $\frac{2}{3} + \frac{1}{3} + \frac{1}{30}$  by 10.

The doing as it occurs :

$$\begin{array}{rcl} & 1 & \frac{2}{3} \cdot \frac{1}{3} \cdot \frac{1}{30} \\ / & 2 & 1\frac{2}{3} \cdot \frac{1}{10} \cdot \frac{1}{30} \\ & 4 & 3\frac{1}{2} \cdot \frac{1}{10} \\ / & 8 & 7\frac{1}{2} \\ & - & \hline \end{array}$$

Total, 9 loaves. There is it."

As so often happens the working is not given, but only the proof: how the share of each man, namely,  $\frac{2}{3} + \frac{1}{3} + \frac{1}{30}$ , is arrived at we are not told. But evidently the Egyptian, dealing with  $\frac{1}{10}$  (or rather with the idea of  $\frac{1}{10}$ ), saw that he could handle it better, break it up more easily into aliquot parts, when in the form  $\frac{2}{30}$ , *i.e.*  $\frac{20+6+1}{30}$ . He evidently found 30 a convenient *mokhraj*, and he uses it again and again, for his 7, 8, and 9 loaves. When he proceeds to verify, by multiplying his result by 10, we see how skilfully he uses his fractions, retaining only the aliquot parts; in his first duplication he sees at once, or knows from his tables, that  $\frac{2}{3} = \frac{1}{3} + \frac{1}{3}$ , that  $\frac{2}{30} = \frac{1}{15}$ , and that  $\frac{1}{15} = \frac{1}{10} + \frac{1}{30}$ .

Note the curious phrase "the doing as it occurs." Prof. Peet goes to some pains to justify his rendering; but Baillet (from whom he differs) is not the only scholar who has seen in these words the plain "Do thus," *ποίει οὕτως*, which Hero employs in a similar way, and which reappear once more in the late Greek of the Akhmim papyrus. Hero of Alexandria has a great place, and Diophantus of Alexandria has a greater, among Greek mathematicians; but they may both of them have been Egyptians after all. I have, by the way, my doubts (however little they may be worth) even of the great Archimedes—for Sicily has been time out of mind a meeting-place of many races of men. I once asked a learned Orientalist what he would make of the name Archimedes, were he told that it was an Arab name, with the "Al" before a rough breathing softened by corruption into *Ar*. Without a moment's hesitation he said "Al-Hamad, of course!" It would be strange indeed if Archimedes, as great a mathematician as ever lived, was just one of those learned Sicilian Maghrebim, such as long

afterwards are said to have taught Leonardo Pisano and Leonardo da Vinci himself.

"A quantity whose fourth part is added to it becomes 15." This is an example of what is commonly called the *hau*, or *heap*-calculus. The word *hau*, or *'h'w*, Prof. Peet describes as "a mathematical-technical term equivalent to our 'quantity'"; he calls it a good example of the concrete nature of Egyptian mathematics. The Sanskrit arithmeticians use a precisely equivalent name; the Arabs called it by a word meaning "possession," or "sum [of money]," a meaning which survives in the "*avere*" of Leonardo. These arithmetical terms are curious and interesting in themselves; and all the more because they are separate and distinct from another series with kindred meaning, which arose afterwards, including the Arabic *shay*, "the thing," Italian *cosa*, German *die Coss*, etc.; these latter terms came in with algebra—"la règle de la chose," as they called it in the early sixteenth century.

Coming back to our problem, the Egyptian proceeds as follows: "Reckon with 4: you are to make their (*sic*) quarter, namely 1: total 5." Here, as Rodet points out, the process is precisely that enjoined in the medieval (Moorish) arithmetics: Look for the smallest number such that we can take of it the fractions required, in the form of known numbers; and add these fractions to the number itself. "Reckon with 5 to find 15 . . . the result is 3. Multiply 3 by 4, etc." The problem is thus dealt with as one of simple proportion. The word which Prof. Peet translates "reckon with" (*w:h, w:h tp*) has, by the way, been the subject of much discussion; Prof. Peet's rendering is at any rate on the safe side, and his explanation seems to be quite new.

"I go three times into the *hekat* (bushel); a third of me is added to me, a third of a third is added to me, and a ninth of me is added to me. I return fully satisfied. What is it that says this?" The fractions are added together, and the whole is shown to amount to  $3\frac{1}{2} + \frac{1}{18}$ ; by this quantity, then, the 1 bushel has to be divided, or rather, in the first instance, the *unit* has to be divided. After the usual process of "dimidiation,"  $\frac{1}{4} + \frac{1}{32}$  of the said amount are shown to sum up precisely to one; and it is then easily shown that, in one *bushel* of 320 *ro*,  $\frac{1}{4} + \frac{1}{32}$  is equivalent to 90 *ro*. The whole procedure is purely arithmetical; there is no *x*, there is no equation—there is no algebra.

A more difficult problem is: "A hundred loaves [in arithmetical proportion] to 5 men, one-seventh of the first three men to the two last. What is the difference of share?" The *regula falsi* is applied: we are told, that is to say, to give one loaf to the first

man; but we are then told, or told to suppose, the common difference to be  $5\frac{1}{2}$ —which is the crux of the problem. Prof. Peet says that "the trial numbers chosen are not really arbitrary, but are chosen because they were already known to be suitable for the purpose." Be that as it may, the old arithmetician would soon discover the required progression by his usual method of trial and error; starting with one loaf as the first man's share, and trying successively common differences of one loaf, two loaves, etc., he would not be long of finding when the three lowest terms were just one-seventh of the two highest. It is no difficult matter for us, nor was it perhaps for him, to see that under these conditions the common difference is always  $5\frac{1}{2}$  times the lowest term.

The following simple problem illustrates some notable features. "To divide 3 *setdt* of land into 5 fields. You are to operate on 5 *setdt* to find 3 *setdt* of land." Observe that whereas *we* should divide 3 *setdt* by 5, to find so many *setdt* or parts thereof, the Egyptian divides 3 *setdt* by 5 *setdt*, obtaining a pure number. He is right and logical in doing so, because his whole method consists in comparing two series of *numbers*, and demonstrating the equivalence between them, namely:

$$\begin{array}{r} 1 \qquad 5 \\ / \frac{1}{2} \qquad 2\frac{1}{2} \\ \cdot / \frac{1}{10} \qquad \frac{1}{2} \end{array}$$

Therefore, since  $2\frac{1}{2} + \frac{1}{2}$  sum up to 3, so also do  $\frac{1}{2} + \frac{1}{10}$  sum up to the fraction required. But in his proof, when he has to multiply that quantity by 5, he does not speak of  $(\frac{1}{2} + \frac{1}{10})$  *setdt*, for he knows that it is so much *land* which he is now multiplying, and he has no name or sign for  $\frac{1}{10}$  *setdt*; he has to translate his fraction at once into  $\frac{1}{2}$  a *setdt* plus 10 cubits of land. He has passed from pure number to land-measure, with its own appropriate notation or nomenclature.

The many more difficult problems, of mensuration of areas, volumes, etc., are too lengthy to be dealt with here; once more, we must refer the reader to Prof. Peet's book. Its value lies not only in the new matter which it contains, but in the clear and very readable account it gives of what we already knew; it will hold its own for many a day as the best account of Egyptian mathematics; it will add not a little to the high reputation which, as Craven fellow and Liverpool professor, as scholar, teacher and explorer, its author has already won. Prof. Peet has done all he claims to do, and from the Egyptologist's point of view his task is done; but I fancy that the historian of mathematics has still a vast deal to do in the comparative study of Egyptian and other early arithmetics.

D'ARCY W. THOMPSON.

### Physiology for Zoologists.

*Grundriss der vergleichenden Physiologie.* Von Prof. W. von Buddenbrock. Erster Teil: *Sinnesorgane und Nervensystem.* Pp. iv + 276. (Berlin: Gebrüder Borntraeger, 1924.) 14s.

THE first feeling of the reviewer in laying down this book by Freiherr W. v. Buddenbrock, professor of zoology at Kiel, is one of regret that it is not written in the English language so as to be more freely accessible to our university students of zoology. The publication of this comparatively elementary text-book may be taken as symptomatic of the growing appreciation on the part of zoological teachers of the importance of the physiological side of their subject.

The habit, widespread during the past few decades, of exponents of the morphological and the physiological sides of the study of living creatures to ignore one another, has had deplorable results in slowing down progress by limiting that breadth of vision upon which all great advances depend. The book under review is not alone in suggesting that the end of this unfortunate period is at hand, and that it will be succeeded by one in which the new generation of zoologists will realise fully the importance of combining morphology and physiology together in fertile union. A phrase in the author's preface suggests a possible danger which will have to be guarded against. As he correctly states, the present movement of zoology towards the physiological side is "a sound reaction" against the prevalent narrow morphology: the need will be to control this reaction and prevent it from going so far as merely to replace a relatively sterile morphological training by an equally sterile physiological.

The present volume, constituting the first part of Freiherr v. Buddenbrock's text-book, is devoted to the nervous system and is divided into two main sections, the first dealing with the senses and the second dealing with the physiology of the nervous system apart from sensation.

In the first of these the subject matter is treated according to the nature of the stimulus with which the particular sensation has to do—under such headings as "Light sense," "Mechanical sense," "Chemical sense," "Temperature sense"—each heading being in turn divided up under convenient sub-headings. Thus under the main heading "Light sense" we have special sections dealing with shadow-reflex, photo-kinetic reaction, effect of light upon the tonic contraction of muscles, effect on direction of movement, conditioning factors of phototactic movements, stationary orientation towards light, "compass" movement, appreciation of form, the eye as a piece of physical

apparatus, accessory arrangements of the eye, colour sense, black as a sensation.

Under the heading "Mechanical sense" the author deals with touch, with the activities of such organs as the halteres of dipterous flies and the sensory tentacles of jelly-fish (concerned not with the setting free of definite reflex movements, but rather with the control of the ordinary movements of the body), with the sense of movement and the sense of position, the special activities of otocysts or statocysts in this connexion, and the sense of hearing.

"Chemical sense" is dealt with under the headings smell and taste. Reference is made to the interesting work by Matthes upon the power of sniffing, *i.e.* drawing a current of the external medium through the olfactory organ, but it should have been mentioned that this faculty makes its appearance for the first time in the vertebrate series, not in urodele amphibians, but within the group of fishes. The fact that *Lepidosiren* possesses this power was observed nearly thirty years ago, and the description given in the text of the behaviour of newts sniffing at pieces of earthworm under water is textually accurate for the behaviour of young *Lepidosirens* in similar circumstances. The manner in which the mechanism for sniffing has originated in evolution is also clearly indicated by one of the Dipnoi, namely, *Protopterus*, in its ontogenetic development.

The second half of the volume opens with a short résumé of the general physiology of the nervous system, and this is followed by a sketch of what is known regarding the special physiology of the more important groups of invertebrates—*Cœlenterata*, *Echinodermata*, *Annelida*, *Arthropoda*, and *Mollusca*. In each case the treatment is just what is wanted by the student of zoology—only such matters being gone into as appear to the author to be, in the present state of knowledge, of real importance. The student's interest is not smothered and his breadth of vision obscured by masses of detail.

This special part ends with a short section on *Vertebrata*, in which are brought out the more important points in which this group differs from the invertebrate groups already dealt with.

Differing as it does from preceding text-books on comparative physiology, Buddenbrock's book is, to a certain extent, a pioneer work. Misprints and slips in detail are comparatively few for a work of this character. The book is illustrated by simple, well-chosen figures. The treatment, and a good deal of the substance, is original.

While dotted about the pages of the book occur the names of investigators to whom we owe particular bits of knowledge, there is no attempt made to trace the historical development of the various parts of the

subject, nor are there given any references to literature. Some may count these omissions as serious faults, but to the present reviewer they serve to awaken distant memories of dry-as-dust lectures, consisting of critical digests of the work of successive investigators, which were particularly effective in killing interest, and he cannot but think Buddenbrock's method the better one. There are doubtless others who believe with him that modern biology has suffered much from its overwhelming literature. The easiest of all types of advanced teaching is that which consists of a series of excerpts from literature with more or less critical remarks attached, but it breeds a timorous, relatively sterile type of biologist who will either content himself with being a mere abstracter of other people's work or, if he takes up original research, will seldom achieve more than the mere addition of more detail to that already existing. Buddenbrock's book will leave its reader with the knowledge that comparative physiology is a real and live, if a young, science: it is one which, in the reviewer's opinion, should be read by all university students of advanced zoology.

### Yorkshire.

*Geology of Yorkshire: an Illustration of the Evolution of Northern England.* By Prof. P. F. Kendall and Herbert E. Wroot. 2 vols. Pp. xxii+995+72 plates. (Leeds: Prof. Kendall, Moor Allerton; or H. E. Wroot, 99 Spencer Place, 1924.) 17s. 6d. net.

DIVERSIFIED beyond compare among counties, both in its surface features and in the range and exposure of its outcropping formations, Yorkshire has naturally given rise to a copious stream of geological literature, which has flowed unceasingly ever since the establishment of stratigraphical studies within it more than a century ago. The depth and strength of the current can be gauged well from this latest work, which is in all respects a powerful addition to the stream, with novel and serviceable attributes.

By a happy combination of thorough geological knowledge with skilful literary art, the authors have contrived to produce a work which, while helpful to the trained geologist, will appeal strongly to the much wider circle who, without high technical qualifications, desire to gain some understanding of the building and shaping of their county. While instructive about every formation in Yorkshire, it does not aim at giving a circumstantial account of the stratigraphy, but concentrates mainly upon the parts which have been particular objects of the senior author's researches, thereby introducing a touch of polemic which gives a spice wanting from impersonal compilations, however full and balanced. In the preface the authors plead for

a free use of the imagination in order to lure recruits to the science; and their plea has much in its favour, always provided that the recruits do not follow suit too quickly, as they are rather apt to do.

Among the subjects thus accentuated are the reef-knolls and the underground drainage-channels of the Carboniferous Limestone country; the "wash-outs" of the Coal Measures; the growth-in-place origin of coal; the "cleat" in coal; the deltaic character of the Millstone Grit; the "brockram" of the Permian and other evidence for desert conditions in the rocks; the life-history of the fossil cephalopods; the components of the chalk; the development of the river-system; the Pleistocene glaciation, with special reference to the overflow channels and other evidence for glacial lakes; and various matters of economic interest.

The authors state their opinions, not "dogmatically as Articles of Faith, but as working hypotheses for the reader's own confirmation or rejection in face of the phenomena," and with this attitude they will doubtless welcome the criticism likely to be aroused at points which we have not space to specify.

The technical matter of the work is pleasantly relieved by anecdotal and personal touches, and by biographical sketches, with portraits, of most of the past workers in Yorkshire geology; so that the reader is provided with the history, as well as with the interpretation, of the stratigraphy. The work is divided into three parts: the first (655 pp.) being the main text, to which we have just referred; the second (70 pp.), a description of the geological sections and features to be observed along the principal railways; and the third (230 pp.), "Specimen days in Yorkshire," intended as a guide to a series of geological excursions covering every part of the county. In the last two parts the local descriptions serve to amplify and systematise the stratigraphical account in the main text, so that in one part or another the student is provided with a fairly full account of every formation. Fully illustrated with well-chosen and well-printed plates and text-figures, many reproducing the artistic geological photographs which we owe to the ripe judgment and skill of Mr. Godfrey Bingley, the work, beside its scientific consequence, cannot fail to arouse pleasurable memories in any one who has ever felt the spell of the Yorkshire scenery.

In these days of dear printing, the cheapness of the work is amazing, but is explained by the authors in the preface. Failing to find an amenable publisher or practicable terms for printing at home, they have had the printing done in Vienna, and are themselves the publishers and distributors.

The result has justified the experiment, as the typing is excellent and the misprints few and un-

important. The copy before us is bound as a single volume, but we understand that the work is now bound in two volumes and will be supplied in this form only, which is certainly the better way in view of the intent that Parts II. and III. are to serve as a local guide-book. For such a purpose the single volume is decidedly too bulky.

As a point of minor criticism, we may note that the dual authorship is curiously exemplified by the numerous instances in which the senior author is referred to by name or in the third person, a construction which unnecessarily accentuates the duality.

G. W. LAMPLUGH.

### The Falkland Islands.

*The Falkland Islands.* By V. F. Boyson. With Notes on the Natural History, by Rupert Vallentin. Pp. 414+24 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 15s. net.

EARLY in the sixteenth century a group of islands to the east of Patagonia began to appear on charts. It is not clear who first sighted them, but Miss Boyson is inclined to give the honour to Amerigo Vespucci and to identify with the Falkland Islands the land which the Florentine astronomer claimed to have discovered in 1502. In any case, the history of the Falklands did not begin until the voyage of Cavendish and Davis in 1592. From then until the battle of the Falklands, Miss Boyson traces the varied history of the islands and the adventures of rival whalers and settlers which led to the curious claim of the Argentine to the sovereignty of the group, a claim that was maintained long after they had become a British colony inhabited entirely by British settlers.

From a scientific point of view, the second half of the book is of most interest in its full treatment of the cattle and sheep-farming and of the sealing and whaling in Falkland waters. To these chapters are added others on the climate and natural history. The cattle introduced by the early settlers eventually ran wild, but were gradually exterminated as sheep became the chief interest of the settlers. This occupation also led to the extermination of the Falkland Islands fox, which was said, with good reason, to attack and kill sheep. Whaling has now left the islands for the dependencies, and fur-sealing for many years has been prohibited on Falkland coasts in an attempt to preserve the few remaining fur seals, but in the past both occupations largely influenced the history of the islands.

The chapters on natural history are by Mr. R. Vallentin and are based on his own work and collections with some, but not complete, references to other

workers in this field. The chapters on climate, stone rivers, and flora are, however, apparently by Miss Boyson. The remarkable stone rivers were originally attributed to volcanic action but now are generally explained by a downward creeping movement of water-logged soil, a process of solifluction during the ice age when the climate was not cold enough to allow glaciers to form but permitted a thick snow covering in winter. Miss Boyson scarcely touches on the problem of the former connexion of the Falklands with the arc of folding connecting South America with Graham Land. A problem of interest which she discusses is the so-called forest bed of coniferous tree-trunks discovered at West Point Island some years ago. Opinion now inclines to the belief that it is built of driftwood. If it is not, it certainly points to a change of climate in quaternary times. The volume is beautifully illustrated and provided with a good map. The historical part in particular is well documented. Altogether it is a work of great value and fills a distinct gap among authoritative works on the British Empire.

### Our Bookshelf.

*Handbuch der Pflanzenanatomie.* Herausgegeben von Prof. K. Linsbauer. Allgemeiner Teil: Cytologie. Band 1: Die Plastiden. Von Dr. Paul N. Schürhoff. Pp. iv+224. (Berlin: Gebrüder Borntraeger, 1924.) 14s. 9d.

THE volume under notice is one of a series on plant anatomy and cytology. Plastids are probably the most characteristic bodies in plant, as contrasted with animal, cells. As a compilation of nearly all that is known concerning the structure and physiology of plastids, this work will fill a useful place. The extent of the literature bearing on the subject may be judged from the literature list of more than 700 titles. The great range of plastid form and structure is considered for the different groups of plants, including leucoplasts and elaioplasts as well as the various forms of chromophores. Under the heading "Constituents of Plastids" the chemical composition of chlorophyll and other pigments, such as fucoxanthin and the carotinoids, is briefly considered. The physiology of chloroplast movement and of greening are discussed, as well as such subjects as "complementary chromatic adaptation." Carbon assimilation, which has its seat in the chloroplasts, is considered at length as a process, and also in relation to the internal physiology and the external environment (light, temperature, and carbon dioxide content) of the plant.

In the final section on the "pathology of plastids" the phenomena of chlorosis, mottling, chimæras and similar topics are included. In this connexion not only the histological structure but also the hereditary behaviour is discussed. The relation of plastids to mitochondria is also considered in another part, but there is no allusion to the important work of Lindstrom and others on the inheritance of plastid differences in varieties of maize.

R. R. G.

*Shaman, Saiva and Sufi: a Study of the Evolution of Malay Magic.* By Dr. R. O. Winstedt. Pp. vii+191. (London, Bombay and Sydney: Constable and Co., Ltd., 1925) 12s. net.

MALAYA has served as a melting-pot of many creeds as it has been the meeting place of many racial strains. Aboriginal tribes, Malays, themselves a composite people, Hindus, Buddhists, and Arabs have all contributed to the conglomerate which comes under the general term of Malay religion. For although in theory a strict Mohammedan, the Malay sees no incongruity in the inclusion of primitive charms among his invocations, and in the prominence, sometimes pre-eminence, of the magician in relation to the Moslem teacher. Although Skeat in his "Malay Magic" was well aware of the composite character of his material, any analysis, except incidentally or when essential to the exposition of his subject, lay outside the scope of his book. The beliefs of the Malays, however, invite, or rather demand, comparative treatment. How far, for example, is the remarkable prominence of the magician in Malay ritual to be regarded as characteristic of a stage of primitive belief? How far can it, as an accompaniment of a peculiar racial strain, be correlated with the highly-strung Malay temperament?

Dr. Winstedt's book is an invaluable, indeed, an indispensable, antecedent to comparative study. He has analysed the tangle into its component parts, describing first the development of the Malay from animist to Muslim, and then the beliefs and rites of each stage. His concluding chapter, which deals with the relation of the magician and all he stands for to the Sufi and Sufi pantheism, is perhaps the most valuable and its subject matter the least generally familiar in the book.

*The Spirit of the Wild.* By H. W. Shepherd-Walwyn. Pp. xx+220+38 plates. (London: John Lane, The Bodley Head, Ltd., 1924.) 12s. 6d. net.

THE author of this book possesses an unusual combination of qualities—a lively interest in and sympathy with animals, keen powers of observation, a facile pen, and a sense of humour. It is not surprising that they should have resulted in the most refreshing book on British mammals that we have read for some time. It is not that Mr. Shepherd-Walwyn has anything really new to tell, so much as the arresting and interesting way in which he puts on record his keen observations of living animals, imparting to the reader some of his own enthusiasm for and sympathy with them.

The author does, however, present a new view-point. His book contains twenty-two chapters, each dealing with one British mammal, and he has endeavoured to sum up in the titles to his chapters the outstanding trait in the character of the animal he is discussing, the driving force which directs its every action, which he calls its spirit. Thus the fox is directed by the Spirit of Craft; the mole, the Spirit of Energy; the vole, the Spirit of Vulgarly, and so on. It is an interesting point of view, and, whether one agrees with the author or not, one is bound to admit that he has managed to convey, both in the titles and in the subject matter of his chapters, a living picture of the animals described, and, on the whole, we should agree with his summing up of their characters.

The book is beautifully illustrated by a series of clear photographs, mainly by Mr. H. Mortimer Batten and Miss Francis Pitt, but including some by the author, Mr. R. Kearton and others. This is altogether a delightful book, and we hope it is not the last that the author will produce.

*Probleme der Astronomie.* Festschrift für Hugo v. Seeliger dem Forscher und Lehrer zum Fünfund-siebzigsten Geburtstage. Pp. iv+475+3 Tafeln. (Berlin: Julius Springer, 1924.) 45 gold marks.

It will be a source of satisfaction to all astronomers that this bouquet of writings gathered in homage to Seeliger was published before his lamented death in December last. The volume consists of thirty-six papers, embracing subjects from abstract dynamics on one hand to the latest astrophysical problems, both experimental and theoretical, on the other. The value of the contributions is sufficiently guaranteed by the list of authors, and though selection is invidious, the names of Jeans, Eddington, Schwarzschild (presumably a hitherto unpublished fragment), von Zeipel, Eberhard, Kohlschütter, Plaskett, Emden, Bergstrand, Schlesinger and Shapley will give an indication of the standard maintained. Some of the articles consist entirely of original research. Others give a general summary of recent work in some particular branch—summaries not easily found elsewhere. As particularly valuable ones may be mentioned Ludendorff's "On the relations between the different classes of variable stars," and Guthnick's "Twelve years of photoelectric photometry at the Berlin Observatory"; also Strömgren's (of which the title had better be left untranslated) "Zu Durchmusterung des Probleme restreint." A paper by van Rhijn contains evidence throwing doubt upon the supposed non-existence of M-stars intermediate between giants and dwarfs. Many of the papers are such as can be read with ease by those not specialists in the particular subjects concerned. E. A. M.

*The Statesman's Year Book: Statistical and Historical Annual of the States of the World for the Year 1925.* Edited by Sir John Scott Keltie and Dr. M. Epstein. Sixty-second Annual Publication; revised after Official Returns. Pp. xxxv+1531. (London: Macmillan and Co., Ltd., 1925.) 20s. net.

THE new edition of this indispensable work of reference appears with its unfailing regularity, and has, as usual, undergone complete revision in its voluminous statistics. As the world settles down there are fewer changes in territorial jurisdiction to record than in recent years, and the number of independent states has ceased to grow. The section on Arabia has been recast and contains a great deal of useful information of recent date. More Russian statistics are now given than was possible a few years ago. The bibliographies attached to each state are a valuable feature of the book, and they have shared the careful revision. Coloured maps show the new boundary between Britain and Italy in Jubaland, and the allied zones of occupation on the Rhine. The introductory tables give statistics of world production of coal, iron, and other commodities and facts concerning the League of Nations. In spite of its 1530 pages, the volume is not two inches thick, which adds to its convenience for reference.

### Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

#### The Coherence of Superposed X-Radiations.

WHAT is probably the most remarkable conclusion from the investigation of the  $J$  phenomenon is that two superposed X-radiations produce effects which are not the sum of those of the two constituent radiations, but are due to the compound radiation as a whole. It is not merely that a constituent of one radiation produces effects in atoms traversed when those atoms are exposed to the action of one or more constituents of the other beam; it is much more than that. The compound radiation, so far as the  $J$  phenomenon is concerned, behaves as an entity with properties of its own dependent upon (average) penetrating power and not on constituent wave-lengths. This follows as a necessary consequence of the laws which we have found, and have already stated ("The  $J$  Phenomenon in X-rays," *Phil. Mag.*, May 1925). We have, however, just obtained the most direct and convincing proof of this.

The absorption of an X-radiation scattered from a plate of aluminium was studied by placing an increasing number of thin aluminium sheets in its path to an electroscope. It was found that at a thickness of 0.05 cm. of absorbing aluminium the intensity as measured in the electroscope suddenly dropped by about 7.5 per cent. This was the  $J_2$  discontinuity, as it occurred when the average absorption coefficient  $(\mu/\rho)_A$  was about 2.0. Thick plates of aluminium were then placed behind the first scattering plate so that while the original radiation studied was unchanged, there was superposed upon it the more penetrating radiation from a much thicker layer, making the combined radiation (on the average) more penetrating. On filtering this combined radiation by aluminium as before, no discontinuity was observed at the stage found in the first experiment—that is, the discontinuity no longer occurred even in the absorption of that part of the radiation from the first scattering plate. Instead of this a discontinuity of the same magnitude (relative) occurred when the filtering sheets had a thickness 0.02 cm. which was the appropriate position for the discontinuity in the radiation as a whole. By "appropriate position" we mean the thickness of aluminium at which the beam as a whole reached the critical absorption coefficient characteristic of the absorber.

Thus two beams which, because of differing penetrating powers, exhibit the discontinuity at differing filtering thicknesses of aluminium, when superposed exhibit not two discontinuities at these thicknesses, but one discontinuity of double magnitude (*i.e.* unaltered relative magnitude) at a thickness between the two shown by its constituents. All this is perfectly consistent with our results from scores of experiments; the discontinuity occurs not at a certain wave-length but at a definite "absorption coefficient" for the whole beam—an absorption coefficient with which we are now perfectly familiar.

The phenomenon may perhaps be more clearly described as one dependent on something analogous to temperature of the X-radiation as a whole, though it is impossible as yet to see how far the analogy will take us. For "absorption coefficient" is more precisely the fractional rate of diminution of ionisation in air (or other gas) with the mass per unit area of

aluminium traversed. This again is approximately the rate (fractional) of transfer of energy from the radiation to the matter through which it passes. (In the case of a fluid flowing with constant speed through a substance, this would be governed by temperature of the fluid.)

Indeed, all our experiments on the  $J$  phenomenon show detachment from mere wave-length and dependence on this absorption coefficient of radiation. The analogy goes further, however, for there is very strong evidence indeed that the  $J$  absorption discontinuities we have observed are of such a magnitude as just to compensate for a deficiency of absorption which under slightly different conditions takes place continuously. (Such discontinuities occur of course when a liquid is superheated or a vapour supersaturated: there takes place suddenly what would under favourable conditions have been a more gradual change of state.) Correspondingly, when the X-radiation is transmitted through matter, absorption does not take place at the rate which appears under slightly different conditions; but when the discontinuity does occur, the deficiency in absorption occurring previously appears quite suddenly. It is as though there were a sudden evaporation (or condensation) of the energy of radiation, when this is in an unstable state so far as its relation with the surrounding matter is concerned, the energy of the radiation being transferred to electrons in the matter traversed.

It ought not to be necessary to say that in the above experiment the whole process can be repeated in inverse order, any feature of it can be repeated, the discontinuities may be displaced,—in fact, the whole of the phenomenon is under perfect control. The magnitude of these discontinuities, too, is remarkably constant, a long series of experiments giving a drop of  $(7.7 \pm 0.5)$  per cent. consistently. Again, we should emphasise that this experiment, though particularly controllable, accurate, and striking, only verifies what, in this laboratory, has been observed less directly in a hundred experiments. The conditions for this "coherence" and its limitations are at present being further studied.

We take this opportunity, too, of announcing that we are now able to show the three discontinuities  $J_1$ ,  $J_2$  and  $J_3$  one after the other by progressive filtering of a selected X-radiation. Each is indicated by a drop of about 10 per cent. in the intensity of the radiation as usually measured.  $J_1$  was first observed in a scattered radiation;  $J_2$  in a characteristic radiation ( $K$  series);  $J_3$  in a primary radiation. We now have them all exhibited in one radiation.

We shall describe elsewhere the application of the  $J$  phenomenon to scattered X-rays.

C. G. BARKLA.

GLADYS I. MACKENZIE.

University of Edinburgh,  
May 30.

#### Radio Transmission Round the Earth.

A THEORY which would explain the facts of long-distance radio transmission must take into account the differences between day and night transmission, long- and short-wave transmission, etc., and must connect these with a plausible assumption with regard to the constitution of the upper conducting or refracting layer, which is believed to function as the chief agency in bending the rays round the earth.

The effect on transmission of such a layer, which has been shown by many eminent scientific men to account in an adequate way for the bending of the rays

round the earth, is determined entirely by its capacity for absorption of the energy of the rays which pass by or through it. G. N. Watson has shown that in the special case investigated by him, the absorption suffered by a wave travelling in the space between two concentric shells of resisting material is the same as it would have been had the bounding surfaces been plane instead of spherical. Thus to a fairly high degree of accuracy, absorption and bending are independent of each other, and, as is physically fairly apparent, we can calculate each independently of the other.

It should, therefore, suffice to the first approximation to determine the absorption in the more simple case of transmission between plane bounding surfaces, to get at least a rough measure of the actual absorption in the transmission of waves round the earth.

I should like to give here the results of such an investigation, especially as it seems to explain in a broad way all the main features of long-distance transmission in daytime. In this investigation a radially symmetrical transmitter was assumed to be situated on the earth's surface. At a height "H" above the earth a reflecting layer was postulated, and

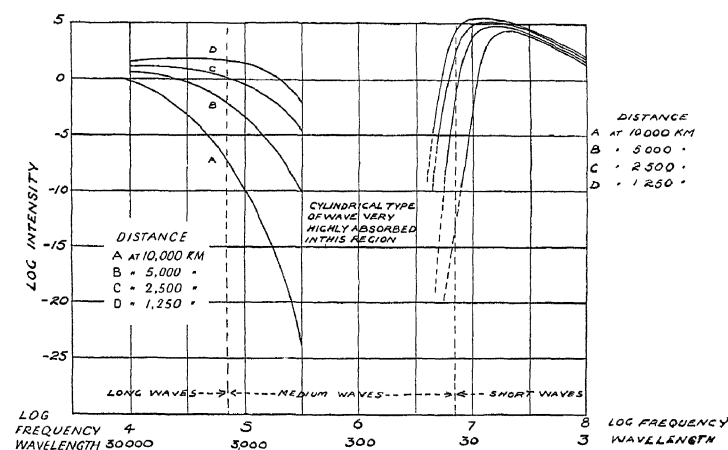


FIG. 1.

the complete problem of the spreading out of electromagnetic waves between the two layers was investigated for all values of electrical constants of the layer as well as for all wave-lengths in the radio range. The constants of the medium which enter directly into the equations are "resistivity" and "dielectric constant." These in their turn depend on the ionic mechanism of the conducting layer, according to the well-known relations of the ionic theory.

By assuming that in daylight the height of the upper layer is approximately 40 km., in accordance with the evidence given in a previous letter to NATURE (April 4), and that  $\tau$ , the mean time between collisions, is of the order of  $10^{-6}$ , we obtain results which, so far as measurements have been made, are in rough agreement with the observed facts of long-distance transmission. The theory indicates that there are in general two types of wave: first, a cylindrical wave which varies inversely as the square root of the distance, multiplied, of course, by a suitable attenuation factor; and, secondly, a spherical wave varying inversely as the distance. The relative importance of these two types is a function of the wave-length and distance.

The theory further indicates that there are in the daytime three fairly well defined ranges of wave-length, each characterised by a different type of absorption, the transitions from range to range occur-

ring approximately at 40 m. and 4000 m. Short waves less than 40 m. of the cylindrical type, and long waves greater than 4000 m. of the same type, suffer only small absorptions; the waves intermediate between 40 m. and 4000 m. being characterised by large absorption. In this range only, the spherical type of wave is the most important, but here the theory no longer applies, since this type of wave is largely modified by the earth's curvature.

The physical aspect of these effects is fairly obvious, for if the layer were either a perfect metallic conductor or a perfect dielectric with a dielectric constant less than unity, the waves would be transmitted round the earth without loss. On the long waves, where  $\tau$  is small compared with the time period of the waves, the layer acts as a good metallic conductor; on the other hand, on very short waves the effect of collisional dissipation is very much reduced and the layer acts as an almost perfect dielectric which with ionic loading has an effective dielectric constant less than unity, and consequently bends the rays round the earth with only little loss.

In the intermediate range the loss is a maximum and the absorption is consequently at its greatest.

This should serve in a rough manner to illustrate the numerical results which are shown in the diagram (Fig. 1). The ordinates here represent the logarithm of the intensity, and the abscissæ the logarithm of the frequency; the curves are calculated for transmitters of constant "metre amps."; i.e. the product of the current in the aerial and the effective height of the aerial is assumed constant.

The most marked characteristic of this diagram is the drop in intensity in the intermediate range of wave-lengths, and the sudden rise in signal strength on short waves. This illustrates very well the known fact that the absorption on 100 m., say, is so high that transmission over distances greater than about 2000 km. in daylight is impossible, whereas on 30 m., daylight transmission over quite long distances, i.e. greater than 10,000 km., has been achieved with only little transmitting power.

On the long-wave range, i.e. waves greater than about 5000 m., the agreement with theory is quite close, for a large number of measurements have been made at varying distances from the transmission stations which agree quite definitely with a transmission formula based on the conducting layer theory (G. N. Watson, Proc. Royal Soc., A, vol. 95, July 15, 1919), i.e. of the form:

$$E = \frac{120\pi hI}{H\sqrt{\lambda R} \sin \theta} e^{-ad/\sqrt{\lambda}}$$

It would appear, then, that what may be called the Eccles-Larmor theory of refractive bending, and the Watson theory of a conducting layer, are each applicable in their particular range of wave-length; the former for very short waves, and the latter for very long ones.

T. L. ECKERSLEY.

Research Department,  
Marconi's Wireless Telegraph Co., Ltd.,  
Chelmsford.

### Spiral Springs of Quartz.

IN connexion with some work on gravitation, I felt the need of a spiral spring of greater delicacy than is ordinarily met with in the laboratory. With the help of my assistant, Mr. A. Glodenis, I have succeeded in making satisfactory springs of quartz. Our very first effort with an improvised apparatus resulted in a spring of four turns of about two centimetres

diameter, possessing excellent elastic properties. Three one-hundredths of a gram gave an extension of one centimetre—this was indeed a short and powerful spring in comparison with those we succeeded in making later.

The following is the method of manufacture.

A small hole is drilled into the body of a carbon cylinder near one end, a splinter of fused quartz being driven into this hole. Having fixed the cylinder in place as the protruding axle of a mounted wheel, the splinter of quartz is fused to a fixed piece of fused quartz by means of the oxy-acetylene flame. The junction, kept as near to the cylinder as possible, is kept constantly heated, while the carbon cylinder moves uniformly with the motion of an advancing screw.

It is better to split the cylinder into two halves, separating them at the ends by means of two slightly tapering wedges. Having wound a spring, the wedges are carefully extracted and both halves of the cylinder are brought into contact, whereupon the spring can be gently blown on to a thinner glass rod.

Carbon is used because it resists fusion and because it is easier to see the spring on a black background. To avoid impairment of vision, it is advisable to view the fusion of the quartz under coloured glass.

K. ŠLIUPAS.

The Physical Laboratory,  
The University of Lithuania,  
Kaunas, May 4.

I HAVE read the letter on "Spiral Springs of Quartz" by Dr. Šliupas with very great interest, and I should like, if he will allow me to do so, to congratulate him and his assistant, Mr. Glodenis, on their success.

When I was working on quartz fibres in the late 'eighties of the last century I made an attempt in this direction, but an unsuccessful one. This was based on a perfectly successful production of a helical spring made of spun glass, and though I showed that at the time I do not remember describing its mode of production. I turned a slightly tapering iron mandrel about  $\frac{1}{16}$  inch (5 mm.) in diameter and mounted it so that it could be turned round with its axis either level or slightly inclined. A length of spun glass was attached near one end of the mandrel with (I think) a spot of shellac varnish. When this was dry a weight was attached to the lower end of the glass fibre. The weight was wound up by turning the mandrel as by a windlass and the other end was similarly fastened. The helix could be wound either close or with any spacing desired by suitable inclination of the axis. The mandrel wrapped with fibre was then buried in fine gunpowder charcoal in a box and heated to fix the form of the helix. At my first attempt I employed a red heat, but the chemical action of the charcoal reduced the lead in the glass and it was no use. Heating another one to some unknown temperature below a red heat completely fixed the form, but in this case the lead was not reduced and a perfect weighing machine was so made. The slight taper facilitated removal of the fibre from the mandrel. I am afraid to say now what small amount was within the limit of observation.

What surprises me about the method of Dr. Šliupas is that he should be able to produce the quartz fibre practically in contact with the carbon cylinder and of useful uniformity. I note that he used acetylene, which I have always feared might have some action on the quartz. For this reason I have never used it or coal gas, only hydrogen. So far as I can remember now I found that a quartz fibre treated in the manner

which succeeded with glass had become rotten, and in the light of the reduced lead in the glass I had some misgivings as to the immunity of the quartz, but I did not pursue the matter.

The glass spring made as described above was perfect in its regularity of form. I have some vague recollection that I found that spun glass annealed as described was much more free from "after-working" than raw spun glass, but the perfection of the quartz fibre in this respect caused me to lose interest in the improvement of glass.

C. V. BOYS.

#### Bioluminescence.

RECENTLY I had occasion to make an electrical joint in the dark, and while unrolling the insulating tape I observed along the line of separation a band of green light. The tape in question is manufactured by the County Chemical Company, Ltd., of Birmingham, under the trade name "Chemico." Several other types of adhesive tape that were examined did not exhibit the phenomenon.

As the green colour immediately recalled the appearance of the light emitted by certain living organisms, I have ventured to use the above heading, "Bioluminescence."

When the tape is unrolled slowly in a dark room, a faint band of green light appears. As the speed of unrolling is increased, the intensity of the light becomes greater, but the colour does not change. At moderate speeds the light is remarkably vivid.

Its appearance is not due to any electrical charge which might have been imparted, for example, during the initial winding of the roll. If the unrolled tape is slowly but firmly rewound, the light will again appear when the tape is unwound. Passing the roll repeatedly through a Bunsen flame does not destroy or even appreciably reduce the quantity of light evolved. If the tape is unrolled while totally submerged in cold water, the light appears quite as vivid as in air, but in hot water the intensity is slightly reduced. Similarly, when the tape is heated in air, the intensity appears to be affected, presumably owing to some variation of the viscosity of the adhesive medium.

When the line of separation is examined under the microscope, it will be seen that numerous elastic threads are produced and ruptured in the process of unrolling. It is only when the unrolling is stopped that these threads can be seen, as they cannot readily be distinguished when the green light appears, owing to its intensity.

The energy expended in the actual production of the light is probably very small. It is not to be gauged by the energy required to unroll the tape; the same force may be required to unroll two tapes, one of which emits light whereas the other does not.

There can be little doubt that the phenomenon is one of mechanical luminescence; the sudden extension and possible rupture of the tenacious threads into which the adhesive material is drawn apparently results in the emission of light. The question arises as to whether or not the light occurs during the extension of a thread or at the moment of rupture. If under a low power microscope the tape is unwound so slowly that the extension and rupture of the threads can be observed, it will be seen that the rupture is confined to about one-third of the total length of the threads, including their thickened roots. If now the speed of unrolling is increased until the light appears, it will be seen that the whole of the threads, including the thickened roots, are illuminated.

While it is conceivable that, even if the light were only produced at the moment of rupture, it need not

necessarily be confined to the region of rupture, the evidence seems to be in favour of the luminescence being the result of the sudden extension of the viscous substance.

In view of the uncertainty that exists regarding the source of bioluminescence and the scantiness of the evidence in support of even the oxidation theory, a source of light that so closely resembles that emitted, for example by the glow-worm, must be of interest to zoologists and be worthy of further consideration.

It is suggestive that the contents of the luminous cells are so often described as oily, glutinous, and viscid. Is it not possible, therefore, that these gelatinous cells or their granular contents may be capable of sudden longitudinal extension with the production of light of a bioluminous character?

JAMES WEIR FRENCH.

Anniesland, Glasgow, W.2,  
May 11.

### Dosage with Ultra-Violet Radiation.

THE beneficial results obtained in the treatment of many diseases by the application of ultra-violet radiations raise the question as to which radiation and what amount is specific to a certain effect. This question is rendered the more difficult of answer by the variety of sources used and the lack of specification of the exact conditions of operation.

The variables affecting the health and vitality of a living subject undergoing treatment are sufficiently numerous in themselves to warrant that the ultra-violet radiation used shall be fixed in its character. Records of treatment and effect (which must now daily be compiled) would be rendered the more valuable if the radiations used could be specified. The more accurate the specification is made, both as to spectral character of the radiation as a whole and as to the energy distribution among the various wave-lengths used, the more rapidly will progress result. At best, measurements of ultra-violet energy are difficult, and it is not hoped or suggested that each person responsible for the administration of ultra-violet radiation would make such energy measurements. Help, however, must be afforded to the general user by those exclusively engaged in the study of ultra-violet radiation by intensive attempts at complete and accurate standardisation of the radiations used and in the development of steady fool-proof sources. Both are problems difficult of accomplishment but not impossible, and must ultimately be solved.

Of the devices used as sources of ultra-violet radiation, constancy in the spectral distribution of energy is not approached by any open arc device. Closer realisation of such constancy is given by the use of quartz-enclosed arcs. Referring particularly to mercury vapour lamps, with due specification of the power input and the conditions of use (ventilation, etc.), approximately constant radiation characteristics are realised. The fulfilment of the requirements of constancy and reproducibility of radiation, to be obtained by the use of an enclosed arc, goes hand in hand with the advantages of the manipulation of a fixed closed unit requiring little or no adjustment.

Apart from the sun and open arcs, there exist but three noteworthy sources of ultra-violet radiation available for therapeutic purposes—the mercury arc, the tungsten arc, and the super-heated tungsten filament—each being enclosed in a fused quartz container. The spectral characters of the radiation obtained from these three sources, however, differ greatly. The continuous spectrum of the tungsten filament may be made to reach 290  $\mu$ , but the energy

in this region is small. The spectrum of the tungsten arc is closely packed with lines, none of which carry a preponderating share of energy. This spectrum tails rapidly in intensity towards 200  $\mu$ . The mercury arc spectrum, on the other hand, which extends well into the deep ultra-violet, has the energy of its ultra-violet radiation concentrated about relatively few wave-lengths.

Despite these great differences in the spectral character of the radiations, no great and fundamental distinction appears so far to have been made between the result obtained in the treatment of disease and in the irradiation of vitamin-deficient food-stuffs by radiation from these various sources.

Is it, therefore, to be concluded that radiation belonging to one (or several) of the intense lines in the mercury arc spectrum is responsible for the beneficial therapeutic results obtained? The question presses for answer. The production of vitamin properties in food-stuffs appears to be a subject peculiarly amenable to exact study; and an examination of the results to be obtained by the ultra-violet irradiation of vitamin-deficient food-stuffs using the different sources in turn and with complete specification of the conditions of their use, would help towards our understanding of the mechanism of the changes which are induced.

H. D. H. DRANE.

Research Dept.,  
The Thermal Syndicate, Ltd.,  
Wallsend-on-Tyne.

### The *K* Absorption Levels of the Light Atoms: A Correction.

IN Roy. Soc. Proc., A, vol. 104, p. 455 (1923), I gave the results of measurements of a number of "soft" X-ray absorption levels. The  $\nu/R$  values of the levels were deduced from the kinetic energies of the groups of electrons expelled from the atoms by X-rays of known frequency. In most cases the results agreed very well with the values deduced from spectroscopic X-ray data, but fairly wide systematic deviations were observed in the case of the *K* levels of the light atoms—my values being appreciably higher than those previously accepted. In the case of the oxygen *K* level the value of  $\nu/R$  came out 42.3, which is 4 units—more than 50 volts—greater than Kurth's value of the *K* critical excitation potential for oxygen (Kurth, *Phys. Rev.*, 18, p. 461, 1921).

As was pointed out in the original paper, my method of measurement was not suitable for exact determinations of very "soft" levels: the results in these cases come out as the difference between two large and nearly equal quantities, one of which is deduced from the measurement of a magnetic field and a radius of curvature, while the other is taken from the X-ray spectroscopic tables. Any inaccuracies in the values of the universal constants  $e$ ,  $e/m_0$ , and  $h$  would introduce systematic errors into the calculations, the effects of which would be most marked in the case of the levels of lowest energy. Apart from uncertainties of this kind, an error of 1 part in 1000 in the absolute value of the magnetic field would cause an error of nearly 3 per cent. in the value of  $\nu/R$  deduced for oxygen *K*. I stated, however, at the time that the deviations of my results from the older results were too big to be accounted for by defects in the method or errors in the measurements (*loc. cit.* pp. 478-9). I now wish to correct this statement.

I have recently extended the series of measurements of corpuscular spectra, with new and improved apparatus (work now in course of publication in the

*Phil. Mag*). The new measurements of such of the *L*, *M*, and *N* spectra of the heavier atoms as have been repeated agree excellently with my original values (within 1 part in 1000). In recording the spectrum of uranium with a target of uranium oxide, I obtained, however, a line which was clearly due to the oxygen *K* level. This line falls about midway between the uranium *N<sub>V</sub>* and *N<sub>VI</sub>* levels, which are fairly widely separated. Measurements on this gave a much lower value for the oxygen *K* level—namely,  $\nu/R$  36.7 instead of 42.3—and this led me to re-determine the other values for the light atoms. The revised values are :

Element.	$\nu/R$ <i>K</i> Level.	Other Values.
20 Calcium	296.6	297.5 F.
16 Sulphur	180.3	181.8 F.
12 Magnesium	93.6	95.8 F.
11 Sodium	76.6	..
8 Oxygen	36.7	{ 35.3 M 38.3 K.

F. = Fricke, M. = Mohler and Foote, K. = Kurth.

It is clear from the new measurements that in the earlier experiments the Helmholtz coils must have moved. During the work on the heavier elements the magnetic fields were calibrated from time to time and found to remain perfectly constant. The light atoms were tested at the end, just before the apparatus was dismantled, and no re-calibration was made in this case. The new work shows quite clearly that only the measurements on the light atoms were affected by this accident. H. ROBINSON.

Physical Laboratory,  
The University, Edinburgh,  
May 27.

#### Anomalous Dispersion and Multiplet Lines in Spectra.

RECENTLY, H. B. Dorgelo has carried out a series of measurements of the intensities of the components of multiple spectral lines (Dissertation, Utrecht, 1924) and obtained results of great interest. He found that the doublets of the sharp series of the alkalis had a 2 : 1 ratio of intensity, the triplet components of the sharp series of the alkaline earths had a 5 : 3 : 1 ratio, the triplets of the sharp series of a sextet system had a 4 : 3 : 2 ratio, and the triplets of an octet system a 5 : 4 : 3 ratio. The theoretical interpretation of this result has been discussed by Sommerfeld ("Atombau," Fourth Edition, p. 649) and by Ornstein and Burger (*Zeit. für Physik*, 1924, 24, p. 41). As illustrations of Dorgelo's work may be quoted the case of the triplets of manganese 6021, 6016, 6013, which show a 4 : 3 : 2 intensity ratio.

Probably the best known case of the existence of simple intensity relationships of this kind are the two D-lines of sodium, for which a 2 : 1 ratio has long been shown. The anomalous dispersion of sodium vapour has been extensively studied, notably by Roschdestwensky, who found (*Ann. der Physik*, 1912, vol. 39) that of two constants  $a_1$ ,  $a_2$  in the dispersion equation

$$n = 1 + \frac{a_1 \lambda^2}{\lambda^2 - \lambda_1^2} + \frac{a_2 \lambda^2}{\lambda^2 - \lambda_2^2},$$

where  $\lambda_1$  and  $\lambda_2$  are the wave-lengths of the two D-lines,  $a_1$  was just twice as large as  $a_2$ . Dorgelo's work suggests that, in the case of multiplet lines, similar numerical relationships between the constants of anomalous dispersion should be found. Unfortunately, very little in the way of quantitative data on anomalous dispersion is available except in the case of the alkali metals.

Perhaps the best work in this direction is that of A. S. King at Mount Wilson, who with the electric furnace studied the anomalous dispersion of iron, chromium, titanium, and manganese lines (*Astro-physical Journal*, 1917, 45, p. 254). An enlarged photograph of the anomalous dispersion due to the manganese triplet 4031, 4033, and 4035, which belongs to the sextet system, reproduced with King's paper, has been examined, and it is found that the dispersion constants  $a_1$ ,  $a_2$ , and  $a_3$  of the lines deduced from the photograph agree closely with the 4 : 3 : 2 ratio to be expected on theoretical grounds. In the case of the chromium triplets 5208, 5206, and 5204, Dorgelo obtained experimentally an intensity ratio of 100 : 72 : 45, while King's photographs give the ratio of anomalous dispersion to be roughly as 100 : 75 : 50, which is a fair agreement. A careful study of the original negatives secured at Mount Wilson may be suggested as likely to furnish further data regarding these interesting spectral relationships.

C. V. RAMAN.  
S. K. DATTA.

#### A New Standard Solution for Sahli's Hæmometer.

SINCE Sahli's hæmometer has come more and more in practical use for the colorimetric inspection of human blood, there has been no lack of experiments to obtain a standard liquid which will keep its colour in daylight better than the indicated hæmatine solution. Most experimenters have clung to Sahli's principle, that in quantitative determination of the contents of iron in blood, the standard liquid should be, so far as possible, the same as the blood solution to be examined. This research is limited to the derivatives of hæmoglobin and has not yet produced the desired result, so far as I know.

The cheapness of the instrument being admitted as a main factor, leads to the use of aniline and similar fluids as a standard. These products have not the slightest chemical relation with hæmoglobin; and they all have the fault that they do not retain colour.

A third standard is the coloured solid glass staff—in fact the combination of Fleischl's and Sahli's hæmometer. Although the colour of the glass seems to last, this standard gives different results, depending upon the kind of light in which the blood determination is made.

I think it advisable to use as a standard a solution of chlorophyll (or related products—the phlobaphenes), namely, an extract of leaves, browned to the darkest tint. It has been proved to be possible to get in this way a solution imitating absolutely the colour of Sahli's standard, having the following advantages :

(1) Chlorophyll is from a biological and chemical point of view more similar to hæmoglobin than any other chemical product (except the hæmoglobin-derivatives). This advantage is only theoretical.

(2) This solution contains a natural brown colour formed by sunlight (or a similar physical process), so that it seems logical to think it impossible that this colour, once isolated, should undergo further change.

(3) This solution is easily made and is cheap.

The simplest way of making this standard solution is as follows :—Tea leaves should be macerated for one hour in an antiformine-water mixture (for example, 1:10). The more tea leaves are taken, the darker the extract becomes. The brown extract so obtained is filtered and the antiformine solution added to it, in a clean glass tube of exactly the same size and kind as Sahli's, until the colour is that of Sahli's standard. The comparison can be made "à vue" or with other

colorimetric methods. The tube is closed by heating the opening, and is now ready for use.

I made a solution for a standard tube one year ago, and although it has been exposed to different kinds of light all the time, it has not changed.

A. K. J. KOUMANS.

University Hospital, Leyden, Holland,  
May 5.

### Approximations to the Probability Integral.

RECENT numbers of NATURE contain two interesting approximations to the probability integral, one by Prof. H. C. Plummer (October 25, 1924), and one by Mr. S. Krichewsky (January 10, 1925). A comparison made by the latter shows that of the two different formulæ Prof. Plummer's is more accurate for small values of the argument, but breaks down completely for  $x/\sigma > \sqrt{6} = 2.449$ .

In my opinion, however, the most significant point about such approximations, and the one on which their practical usefulness depends, is the integrability of the resulting equation. In stellar statistics, for example, we are constantly dealing with problems involving integration of the incomplete probability function, and an analytical approximation to erf ( $x$ ) is then invaluable.

I take it that Mr. Krichewsky's formulæ (3) and (5) should read as follows:

$$z = k \left( \frac{a^2}{4} - y^2 \right), \quad y = \sqrt{\frac{a^2}{4} - 10u},$$

$$\text{giving:} \quad y = \frac{a}{2} \sqrt{1 - 10 \cdot 0.5354 x^2 / 2\sigma^2}.$$

This last expression is not integrable. In fact, it is much more difficult to handle, and much more inconvenient to expand into power series, than the original exponential function or its integral.

Prof. Plummer's formula  $\text{erf}(x) = \frac{6}{\sqrt{\pi}} \frac{x}{x^2 + 3}$  is extremely simple, and, when integrated, gives rise to an arc tangent or a logarithm.

Concerning the usefulness of approximations when the values only of the probability function are needed, it may be pointed out that Mr. Krichewsky's formula requires a table of logarithms, and even then takes more time than interpolation from a probability table. Prof. Plummer's formula can easily be memorised, and the entire calculation can be done in one's head, in about the same time as it takes to interpolate from a table.

W. J. LUYTEN

Harvard College Observatory,  
Cambridge, Mass.

### The Word "Australopithecus" and Others.

ALL will admit that many words of Greek origin were used by the Romans, and that *pithecus* was one of them. The evidence adduced, however, does not prove that *pithecus* was regarded as a Latin word. The *pithecium* of Plautus is not a Latin diminutive; it is merely a latinisation of an ordinary Greek diminutive. Had a Roman regarded *pithecus* as Latin, he would not have used the Greek word for "tail" to combine with it: *cercopithecus* is of course pure Greek. Nevertheless had the Roman lived to our day and turned zoologist, he might under stress of circumstances have combined *pithecus* with a word of Latin origin. Circumstances, it is true, did not stress; a good Greek word for "south" was available, and a Roman, especially a "polished Roman," would probably have used it.

But heaven preserve us from pedantry in such

matters! The reason for this letter is that Prof. Dart (NATURE, June 6) does not yet realise the many-sidedness of his offences. No Roman, polished or rude, would have used the adjective instead of the substantive. Had Prof. Dart written *Austropithecus* we should merely have shrugged our shoulders and Australia would have had no grievance.

Then "Homosimiidæ"! The word is not "parallel with Pithecanthropus or Anthropopithecus," because they are correctly compounded and this is not. But, apart from orthography, if a family is to be erected for the special reception of *Australopithecus*, its name, according to the rules, has to be Australopithecidæ. So that's that.

The moral? Not that a distinguished anatomist must necessarily be a classical scholar; but that any one who sets out to propose a name should realise all his responsibilities. In a word, if you want to join in a game, you must first learn the rules.

F. A. BATHER.

### A New Locality for Jurassic Insects.

MR. A. J. LAVRUSHIN, a keen student of geology, who was my interpreter in Siberia, has sent me a careful drawing of a fossil insect which he received from a teacher in the Commercial School at Harbin. It was obtained near the coal mines at Soochan, in the Maritime Province of Siberia. The deposit is known to be Jurassic, probably middle or lower. Mr. Lavrushin says the rock is like that typical of the lower Jurassic. The figure appears to accord perfectly with the larva of the stone-fly *Mesoleuctra gracilis* Brauer, Redtenbacher, and Ganglbauer, known from the Jurassic (supposed middle Jurassic) at Ust Balei, west of Lake Baikal. It seems probable that we have another exposure of these insect-bearing beds, about 1500 miles from the original locality. This, if confirmed, may prove to be a matter of more than ordinary interest. For an account of the Ust Balei deposit and its significance see Bull. Amer. Museum Nat. History, 1924, p. 134.

T. D. A. COCKERELL.

University of Colorado, Boulder,  
May 16.

### Mercury Helide: A Correction.

IN a former note (NATURE, March 7, p. 337), I stated that a quantitative analysis of mercury helide showed that 210.79 parts by weight of mercury combined with 4.18 parts by weight of helium. I have to regret that this is incorrect. In checking the calculations before incorporating the results in my paper (now ready for publication), I discovered that a decimal point had been misplaced. In consequence of this the stated weight of mercury was ten times greater than that actually found. The simplest assignable formula is therefore  $\text{HgHe}_{10}$  and not  $\text{HgHe}$  as at first given.

J. J. MANLEY.

Daubeny Laboratory,  
Magdalen College, Oxford, June 4:

### Quantum Radiation.

WITH reference to my short letter in NATURE of May 30, p. 838, will you allow me to say apologetically that instead of finishing it off abruptly with the statement that the usual formulæ follow, it would have been better if I had said: "After that no doubt the real difficulties begin." My only object was to direct attention to the peculiarity of the fraction  $x/(e^x - 1)$  as almost irresistibly suggesting continuous compound interest growth followed by sudden emission.

ALFRED LODGE.

## A New Determination of the Distribution of Stars with respect to Magnitude and Galactic Latitude.

By FREDERICK H. SEARES and Prof. P. J. VAN RHIJN.

THE significance of the numbers of stars visible in different parts of the sky has been recognised since the time of Sir William Herschel, whose star gauges first indicated the flattened, watch-shaped form of the galactic system. The stars having parallaxes which can be measured, either by trigonometric or spectroscopic methods, are all so near that their distances tell nothing of the structural features of the system. These must be learned from counts, like those of Herschel, of stars of different magnitudes in different parts of the sky.

Were the stars all equally luminous, it would be easy to find their distribution in space. Differences in apparent brightness would then be wholly an effect of differences in distance, and star-counts, together with the parallax of a single star, would determine the distances of all objects within reach of our telescopes. Actually, the range in stellar luminosity is enormous, at least 100,000,000 to 1. Differences in luminosity, however, can be allowed for, provided we can find the numbers of stars of different intrinsic brightness in a given volume of space;<sup>1</sup> but this problem has not yet been satisfactorily solved.

Investigations by Kapteyn and van Rhijn indicated that the distribution of luminosity could be represented by a Gaussian error curve, with a maximum frequency for luminosities 0.07 that of the sun. The present authors, however, have independently shown that this maximum is not real and that the frequencies continue to increase probably at least so far as luminosities equal to 0.001 that of the sun. The highly luminous stars, on the other hand, are well represented by the ascending branch of an error curve. Thus at present we have an excellent approximation for the relative numbers of stars intrinsically brighter than the sun, which stands about midway in the known range of luminosity, but only general indications as to the behaviour of fainter stars. This somewhat restricts the immediate usefulness of star-counts but does not lessen their ultimate value.

The star gauges of Sir William Herschel were extended to the southern hemisphere by Sir John Herschel in 1834-38, and the accumulation of star-counts thus begun has been continued by others, in recent years especially by Kapteyn and van Rhijn, whose respective distribution tables are in "Groningen Publications," Nos. 18 and 27. Successive revisions of the data have extended the counts to larger areas of the sky and to lower limits of brightness, and have also improved the scale of magnitudes to which the counts are referred.

The serious practical difficulty lies in the magnitude scale, which must be accurate if the counts are to be useful. The range in apparent brightness covered by large telescopes is 20 magnitudes or more. The establishment of standards over this interval requires the ultimate comparison of light sources the intensities of which are in the ratio of at least 100,000,000 to 1. Under the most favourable conditions, sources of the

same order of brightness and of the same colour can be compared with an uncertainty of about 1 per cent.; but as the differences in brightness and spectral composition increase, the uncertainty becomes much larger. Comparable difficulty in the measurement of lengths would mean, for example, an error of several inches in determining the dimensions of a room. An ordinary yardstick does a hundred times better than this, let alone the precise methods of laboratory measurement.

The difficulty of bridging a long interval of brightness by visual methods is illustrated by the scale underlying Kapteyn's table of stellar distribution. This, the best visual scale available up to 1915, is now known to be a magnitude in error at the sixteenth magnitude, the equivalent of 150 per cent. in the light-intensity of the stars to which this magnitude was assigned. Mainly because of this same difficulty the conspicuous increase in the concentration of stars in the Milky Way with increasing magnitude, which was already indicated by the gauges of Sir John Herschel, remained an open question until 1917, when counts of 40,000 stars observed photographically at Mount Wilson put the matter beyond doubt.

The application of photographic methods by Pickering and Miss Leavitt did much to increase the precision, and the resulting Harvard photographic scale, defined by a sequence of stars at the North Pole, is the basis of the distribution table of van Rhijn. Investigations in photographic photometry begun at Mount Wilson in 1910 led to the Polar standards of brightness published by Seares in 1915. These were afterwards strengthened by additional data, and to the sixteenth magnitude have been confirmed at several observatories; below the sixteenth magnitude, however, the Mount Wilson standards are still the only ones available.

These investigations, which comprise the Mount Wilson contribution to the International Scale adopted at Rome in 1922, were preparatory to a study of the distribution of faint stars in the 139 Selected Areas of Kapteyn between the North Pole and declination  $-15^\circ$ , an undertaking now finished. The individual magnitudes will be published in the "Mount Wilson Catalogue of Selected Areas." The detailed discussion of the counts based on these magnitudes and a revision of certain earlier results will also be published elsewhere. Some matters of general interest, however, may be summarised here.

The new distribution table depends on: (a) The Mount Wilson "Catalogue," which completely determines the distribution for stars between magnitudes 13.5 and 18.5; (b) Van Rhijn's tables, "Groningen Publication," No. 27, reduced to the international scale by (a). These afford results for the interval  $m=4.0$  to 9.0 and establish the scale for counts from a third source, (c), consisting of 33 zones of the Astrographic Catalogue between declinations  $-65^\circ$  and  $+62^\circ$ . These counts, published by Turner, include about 1,400,000 stars and determine the distribution in the interval  $m=9.0$  to 13.5.

The Mount Wilson "Catalogue" (a) is based on two partially independent investigations: ( $a_1$ ) measures

<sup>1</sup> Practically we are obliged to assume that the relative numbers are the same at all distances.

made at Mount Wilson on photographs of 15 minutes exposure or less, which establish the scale and give the magnitudes of 65,683 stars in fields 23' in diameter; and ( $a_2$ ) measures at Groningen on Mount Wilson photographs of 60 minutes exposure. These give the magnitudes of 44,910 stars in fields 15'  $\times$  15' or 20'  $\times$  20', based on standards derived from ( $a_1$ ). Most of these stars are included in ( $a_1$ ), so that the total number of individual objects is approximately 70,400. The magnitudes are on the international scale.

The fields in the 139 Selected Areas cover but 1/2500 of the entire sky. Nevertheless, examination shows that had the alternate areas been discussed separately, the two series of counts would have led to nearly identical results. Individual areas show large deviations from the mean, but with the exception of regions in the Milky Way there is little systematic uncertainty. This perhaps as well as anything illustrates the underlying statistical unity of the stellar system. Properly selected, 1/5000 of the stars between magnitudes 13.5 and 18.5 reveal the main features of the distribution with only a small percentage of error.

The densities derived from the combination and adjustment of data for the three intervals 4.0-9.0, 9.0-13.5, and 13.5-18.5 are so regular that they have been extrapolated to the twenty-first magnitude, which is the practicable limit for long-exposure photographs with the largest telescopes. The table, which thus covers a range of 17 magnitudes, gives the logarithm of the average number of stars per square degree brighter than photographic magnitude  $m$  ( $\log N_m$ ) situated in different galactic latitudes. Local irregularities, differences between northern and southern latitudes, and systematic deviations in longitude have been ignored for the present. Averages for latitude intervals 0°-20°, 20°-40°, 40°-90°, and for the whole sky are also given. Correction of the magnitude limits for colour leads to average densities for the entire sky for a grouping of stars according to *visual* magnitude. The complete transformation of the table to visual limits cannot be made at present because of lack of data for the variation of mean colour with galactic latitude.

The total number of stars to the twenty-first photographic magnitude is  $8.9 \times 10^8$ , or, to the twentieth visual magnitude, a round  $10^9$ . It is difficult to specify the uncertainty attached to these numbers. There is no means of testing the magnitude scale for the very faint stars; but if the limiting magnitude of the table is correct within one or two tenths, we may consider ourselves fortunate. Since the average change in  $N_m$  per magnitude at the limit is about one-half of  $N_m$  itself, the uncertainty in the totals from this source alone can scarcely be less than 5 or 10 per cent. Errors in the final counts arising from the choice of regions used as samples, as already stated, must be small, except possibly in low galactic latitudes. The fields in the Milky Way are not numerous, nor are they well distributed in galactic longitude, and the tabular densities are here subject to considerable uncertainty, although the amount cannot be stated.

For bright stars at all points in the sky, the ratio of totals to successive magnitude limits  $N_{m+1}/N_m$  is 2.9. With decreasing brightness this ratio falls off, but most rapidly in the direction of the galactic

poles. Thus in passing from the twentieth to the twenty-first magnitude the total in the Milky Way is increased 1.8 times, while at the poles the increase is only 1.4 fold. Were the stars uniformly distributed in space, the ratio (excluding losses of light by absorption, scattering, etc.) would be constant and equal to 3.98. The actual ratios therefore show that the stars thin out with increasing distance from the centre; that at great distances they thin out more rapidly than near the sun; and that this thinning out is most pronounced in the direction of the poles of the Milky Way—results obviously related to the flattened, watch-shaped form of the system.

The variation in  $\log N_m$  can be used to estimate the probable total of all the luminous stars, both visible and invisible, in any direction, and hence also the total for the system. Earlier data indicated that  $dN_m/dm$  could be represented by an error function for practically all values of  $m$  to the limit of the counts. It was, therefore, natural to assume that the law also applied to stars too faint for observation, whereupon a simple integration gave the required total. The relation between star-counts and the luminosity and density functions indicates, however, that the values of  $dN_m/dm$  for the brighter stars cannot be well represented by an error function, and the present counts confirm this conclusion. Below the twelfth or thirteenth magnitude the representation is excellent, but above this limit the second differences in  $\log (dN_m/dm)$  are not constant. This restriction raises a serious question as to whether the error function applies to the invisible stars. For lack of anything better, we assume that it does apply, and thus find: Total number of stars per square degree in galactic latitude 0°, 5,320,000, one-half of which are fainter than magnitude 30.6. For latitude 90° the total is 7160, with one-half fainter than magnitude 23.9. The corresponding totals to  $m=21.0$  are 73,600 and 1667 respectively. Hence in the direction of the poles of the Milky Way about one-fourth of the stars between the sun and the limits of the system are accessible to observation. In the direction of the Milky Way the fraction is one-seventieth.

Stars of all magnitudes are most numerous in the Milky Way, but the concentration in the galaxy is obviously much greater for faint than for bright stars. At the fourth magnitude the ratio of the values of  $N_m$  for 0° and 90° is 3.5; at the twenty-first magnitude it is 44; to the limits of the system, 743. The importance of the Milky Way as a structural feature of the system is also indicated by the fact that 95 per cent. of all the stars are within 20° of the galactic plane. The remaining two-thirds of the sky contain but 5 per cent., of which less than 1 per cent. is in that third between latitudes 40° and 90°.

Three different methods of summation give values for the total in the system ranging from  $3.0 \times 10^{10}$  to  $3.7 \times 10^{10}$ , of which the lower limit is the most probable value. This, however, like all other results depending on the assumption that the adopted formulæ for  $dN_m/dm$  hold to the limits of the system, is very uncertain. Even at the galactic poles, where a considerable fraction of the stars can be observed, the extrapolation is risky enough; and naturally it is very much more so in the Milky Way, where apparently

less than 2 per cent. of the stars are within observational reach. But whatever the actual total, it is clear that the number of stars beyond the range of the largest telescopes is many times that accessible to observation.

The total amount of starlight is little affected by questions as to the number of stars in the system. For the distribution given above, the stars brighter than the twentieth visual magnitude, comprising but 3 per cent. of the total, contribute 98 per cent. of all the starlight. The integrated visual light for the

whole sky is the equivalent of 1076 stars of visual magnitude 1.0 on the international scale. The corresponding numbers found by Yntema and van Rhijn from measures of the brightness of the sky are 1350 and 1440, the unit being referred to the Harvard scale. The outstanding difference corresponds to about 0.3 mag. Since the stars of about the twelfth apparent magnitude contribute the largest amount of light, no reasonable correction to the magnitude scale will wholly account for the difference.

### The Expedition of the R.R.S. *Discovery*.

THE Royal Research Ship *Discovery*, which is leaving England at the end of the present month, will be engaged for the next two years in oceanographical investigations in the South Atlantic and Antarctic. The ship, which is barque-rigged with auxiliary steam, was built in 1901 for the late Captain Sir Robert Falcon Scott, and was acquired on behalf of the Falkland Islands Government for the purpose of the present investigations in 1923. During the last eighteen months she has undergone extensive repairs, and changes have been made in her masting and sail-plan in accordance with experience obtained by Capt. Scott. She has been refitted throughout, and is now completely equipped for the investigations for which she is intended.

The cost of the expedition will be met entirely from public revenues raised in the Dependencies of the Falkland Islands, and the work will be controlled, subject to the instruction of the Secretary of State for the Colonies, by an executive committee, constituted as follows: Mr. E. R. Darnley (Colonial Office, chairman); Sir Sidney Harmer (British Museum, vice-chairman); Sir J. Fortescue Flannery, Bt. (consulting naval architect); Mr. H. T. Allen (Colonial Office); Mr. J. O. Borley (Ministry of Agriculture and Fisheries); Capt. J. D. Nares (Admiralty), and Mr. J. M. Wordie (Royal Geographical Society); Mr. H. Horsburgh (technical assistant); Mr. E. W. Baynes (secretary).

The scientific officers of the expedition are: Dr. Stanley Kemp (Director of Research); Messrs. A. C. Hardy, J. E. Hamilton, N. A. Mackintosh, J. E. G. Wheeler, L. H. Matthews, and E. R. Gunther (zoologists); Messrs. H. F. P. Herdman and A. J. Clowes (hydrologists). Messrs. Mackintosh, Wheeler, Matthews, and Clowes are at present serving at the shore station, South Georgia. The marine staff includes: Commander J. R. Stenhouse (captain); Lieut.-Commander W. H. O'Connor (chief officer); Lieut.-Commander J. M. Chaplin (second officer and surveyor); Eng.-Lieut. W. A. Horton (chief engineer), and Lieut.-Colonel E. H. Marshall (surgeon).

The principal object of the expedition is to obtain information bearing on whales, more especially on those species which form the basis of the industry now flourishing at South Georgia and in the South Shetlands. Although the whale fisheries in these places are controlled by Government regulations, very little is known of the habits and migrations of the animals and of the reasons for the fluctuation in their abundance. It is, indeed, not yet certain whether the closely similar Arctic and Antarctic whales are specifically identical. There is, therefore, much information to be acquired before a satisfactory basis for the control of the industry can be found.

In connexion with the investigations, a laboratory has been established in Cumberland Bay, South Georgia, where examination is being made of the whales captured at the adjacent whaling station. At this laboratory good progress has already been made, for, although the building was only completed in February, 181 whales had been examined by April 10.

Work on the *Discovery* will mainly be directed towards obtaining information on oceanographic conditions in the waters frequented by southern whales, and routine observations on the hydrography and plankton will be made throughout the voyage. On the whale feeding-grounds intensive work will be undertaken and a close study made of the euphausiids, which occur seasonally in great abundance, and constitute the principal, if not the only food of southern rorquals. Plankton nets will be employed at all depths, the smaller hauled vertically and the larger, up to a diameter of 4½ metres, horizontally. New apparatus for opening and closing horizontal nets will be tried, together with a mechanism designed to allow of a number of vertical nets being operated on a single line. A very large midwater trawl, with three otter boards, 250 feet in length and with a mouth area of about 1500 square feet, will be used in an attempt to obtain large pelagic organisms, particularly cephalopods, which would be able to avoid smaller nets. Depth recorders, of pressure gauge and thermometer types, will be used to check the depths at which towed nets are fishing. For work on the bottom the ship is provided with dredges of various kinds, traps similar to those designed by the Prince of Monaco, the Petersen grab, and both beam and otter trawls, but the latter will ordinarily be used only on the coastal banks where fish in commercial quantities are likely to be found.

The deck equipment for biological and hydrographic work comprises a large trawling winch carrying 5000 fathoms of tapered warp on one reel and 1000 fathoms of trawl warp on the other. An auxiliary reel with 3500 fathoms of 6 mm. wire is driven from this winch. For vertical nets and hydrographic appliances there are four smaller reels, driven by three engines and all fitted with 4 mm. wire. Two of these reels carry 3500 fathoms of wire for deep observations and two carry 500 fathoms for observations at lesser depths. A Lucas sounding-machine is installed with various attachments for the collection of bottom samples, and a dynamometer, accumulators, metre recorders, an electric centrifuge, and other subsidiary apparatus are provided. There are two laboratories on the ship, one on the upper and one on the main deck, completely equipped for biological and hydrographic work.

Adequate photographic apparatus and a dark room are provided.

The ship is well supplied with apparatus for taking observations while under way. Two sets of echo-sounding gear, for shallow and deep water, have kindly been lent by the Admiralty, and a distance thermometer, designed to give a continuous record of surface temperature, has been fitted. The Knudsen full-speed water-bottle will provide water-samples at some distance below the surface, and it is hoped that a new piece of apparatus, designed by Mr. A. C. Hardy, will furnish a continuous record of the more important organisms in the plankton.

The *Discovery* is not equipped with harpoon guns of the commercial type, but will carry smaller patterns, with which it is expected that Cetacea up to 25 feet in length can be obtained. Observations on living whales will be made whenever possible, and it is hoped that valuable information on their migrations will result from marking experiments. The form of mark has been adopted after repeated tests on the shooting-range with a target made of whale blubber, and after practice on living whales made by Prof. Hjort and a member of the *Discovery* staff who accompanied him. The mark is similar in form to a large drawing-pin, with three barbs on the shank, and is made of annealed cast-iron and silver-plated. The pin is  $2\frac{1}{2}$  inches in length and the disc nearly 2 inches in breadth, with a number stamped on it, together with an inscription offering a reward for return to the Colonial Office. Posters and leaflets are being circulated to all the whaling stations of the world giving instructions for the return of the marks, together with the required information. The mark is placed on the end of a light wooden shaft, and is fired from an ordinary 12-bore gun. With this apparatus good practice has been made at ranges up to 70 yards, and the marks embed themselves well even

with the target at an oblique angle. The pin is not long enough to penetrate the blubber, and the operation of marking is thought to be quite painless. It is feared that the *Discovery* may be too slow and unhandy to mark whales in any considerable number, but whale-marking will form a large part of the work of a small auxiliary vessel, of high speed and built on the lines of a whale-catcher, which is now under construction.

Geographical exploration is not included in the programme of the expedition, but it is hoped that the echo-sounding gear will provide valuable data in Antarctic waters, and every effort will be made to improve our knowledge of the coast-line and to survey harbours frequented by the whaling community. The second officer of the ship is a qualified surveyor, whose services have been lent by the Admiralty.

Work will begin in the Gulf of Guinea, which is thought to be the northern limit of migration of southern whales. Observations will be made on the plankton and hydrography of this region, and the whaling stations on the West African coast will be visited. After touching at Cape Town a course will be laid for South Georgia *via* Tristan da Cunha and the Falkland Islands. On reaching South Georgia a close survey will be made of the whaling grounds, and, as at present arranged, in January 1926 the ship will make a passage to the South Shetlands by way of the South Sandwich group, proceeding still farther south to the Neumayr Channel if ice conditions are favourable. In March a return will be made to South Georgia, a line of stations being made between Graham Land and Cape Horn if weather permits. A fresh survey of the whaling grounds is then contemplated, and later in the year, during the Antarctic winter, the ship will possibly return to the African coast. Operations in the second year will depend largely upon the results obtained during the first.

## Obituary.

M. CAMILLE FLAMMARION.

THE death of Camille Flammarion at the age of eighty-three years removes from the world of astronomy one of its greatest ornaments, and one of the most picturesque figures in French scientific circles generally. It is difficult to contemplate astronomy in France without the guiding hand of its beloved "maître," whose "élèves" are counted in all branches of society in all lands.

Camille Flammarion might be described as the apostle of popular astronomy. His numerous literary works had for object primarily the popularisation of astronomical study in all its manifold branches, and it is upon the record of success achieved by those works that his reputation as a scientist should stand or fall. Throughout his life this was a passion with him, kept constantly in view, and meeting with extraordinary success in the birth of the Société Astronomique de France in 1887. This notable Society, recognised by the Republic ten years later as being of public utility, now comprises thousands of members of all nationalities, united by a common love of the sky.

Flammarion was not content to spread abroad the gospel of astronomy by book and pamphlet. He

believed in the practical application of his theories for the spread of a universal knowledge of the sky. Although he was not openly impatient of the restraint imposed on the professional astronomer by the routine of the national observatories, which exist chiefly for the many problems involved in the determination of time and position, it is common knowledge that this branch of astronomy appealed to him very little. His interest lay principally in the discussion of the physical facts observed through the telescope, a much more picturesque branch of the science. He was frankly proud of the scientific independence of his observatory at Juvisy and its freedom from official restraints and controls.

With most modern observatories nowadays devoting special attention to the study of the physical and vital constitution of the celestial bodies, astrophysics has definitely taken its place alongside mathematical astronomy, and it is not going too far to claim that this extension of activity is due in large measure to the demand which arose from the interest created by Flammarion in his efforts towards what the French call the "vulgarisation" of astronomy.

In the year 1882 an unknown admirer, M. Méret,

conveyed to Flammarion, *regium donum*, the beautiful estate and chateau at Juvisy, a few miles south of Paris, where he has since made his home. Here he installed and equipped a magnificent astronomical observatory, to which in later years he added a meteorological and climatological station which is under partial subvention from the French Ministry of Agriculture,—the only climatological station in France, as Flammarion himself boasted, established in direct connexion with the physical study of the sun.

At Juvisy, in the most charming surroundings, the weather is studied in extraordinarily minute detail. The astronomical observatory is thrown open to the eager student of the sky, and competent amateur observers are encouraged to undertake serious observational study there,—perfect instrumental equipment combining very happily with a perfect position, deep in the wooded country and yet within sight of Paris, whose upstanding wonders, the Eiffel Tower and the domes of Les Invalides and the Panthéon, are visible from the observatory terrace.

It was my privilege to visit M. and Mme. Flammarion at Juvisy in the summer of 1914, just before the outbreak of War, and the memory of that experience will not readily be effaced. Conversationally, M. Flammarion was a man of few words, a characteristic not uncommon among very prolific and highly imaginative writers. During a conference of French-speaking astronomical societies which lasted three whole days he rarely joined in the debates, notwithstanding that the subjects discussed were nearest his heart, and that none was present better qualified to deal with them. Once in Flammarion's presence it was obvious that there must be no bandying of empty compliments; no presumption upon a short acquaintance; no departure from the utmost gravity; no congratulations upon good fortune, be they ever so sincere and free from envy.

It must have been a strange scene as the leonine Flammarion, gravid with thought, conducted us round his beautiful and artistic home; through the inscribed monumental gateway opening out of the seventh of the great national roads of France; along corridors with the names of great astronomers and philosophers in ornamental writing on the friezes, and into rooms with the signs of the zodiac and other literary and scientific emblems brilliantly emblazoned on the ceilings or carved on the fittings; introducing us unostentatiously to his treasures with a minimum of words and much less than the usual amount of gesture. Probably to another visitor silence might have been more impressive than actual words, but to me, familiar with that brilliant literary style and fecund imagination which never failed in any of his works, Flammarion's grave taciturnity and his deceptive air of languid indifference were distinctly disappointing, offering great contrast to the eager vivacity of Mme. Flammarion. Subsequent private correspondence with Flammarion has demonstrated the imperfect justice of those impressions, revealing a warm and sympathetic nature which a brief acquaintance refused to discover in him personally.

Whilst Flammarion was a man of many activities, the facts of his astronomical life are few and simple. Born in 1842, his first acquaintance with astronomy dated back to the annular eclipse of the sun on October 9,

1847. At fifteen years of age he was apprenticed to an engraver, and a year later wrote a MS. of 500 pages entitled "Cosmologie universelle," from which later emerged his "World before the Creation of Man." In 1858 he entered the Paris Observatory as a computer, but found under the austere rule of the great Le Verrier little play for his fertile imagination. Leaving the Observatory in 1862, he was immediately welcomed by the Bureau des Longitudes, where he was engaged for three years, presumably in computing work. At the age of twenty-one we find him editing the scientific review *Cosmos*, and in 1864 he commenced the publication of his "Annuaire astronomique," an almanac and astronomical review of unique type, which has now appeared regularly for sixty years. In 1867, Flammarion was recalled to the Paris Observatory by Le Verrier, and placed in charge of one of the largest telescopes for the measurement of double stars. In 1887, Flammarion's review *L'Astronomie* became merged in the monthly bulletin of the Société Astronomique de France, and it is only a few years ago that the original name was restored.

In June 1922, Flammarion's eightieth birthday was commemorated by an immense meeting of his admirers in the great hall of the Sorbonne, Prince Bonaparte presiding in the presence of M. Panlevé. Shortly afterwards Flammarion received one of the greatest honours France has to bestow on a living subject: a commandership of the Legion of Honour.

WILLIAM PORTHOUSE.

THE death on May 26 of Lieut.-Commander Henry Edward O'Neill, R.N., removes one of the last survivors of the pioneer explorers of tropical Africa. Born in 1848, he entered the Navy in 1862 and first saw service in the operations for the suppression of the slave trade on the east coast of Africa. Soon after his appointment in 1879 as British Consul at Mozambique, O'Neill began a series of important explorations between the coast and Lake Nyassa and in the valley of the Shiré river. In five years he completed more than a dozen important journeys and discovered Lakes Amaramba and Chiuta and a new route from Blantyre to the coast. His careful observations of the position of Blantyre made it for long the best fixed position in that part of Africa. In 1885 he was awarded the Patron's medal of the Royal Geographical Society. He was associated with Captain (now Sir Frederick) Lugard in his early work against the slave raiders, and in 1888 distinguished himself in the defence of Karonga, on Lake Nyassa. On his health giving way he was compelled to leave Africa. For a time he was consul at Leghorn and at Rouen, and he retired from the service in 1899. His publications were mainly in the Proceedings of the Royal Geographical Society.

WE regret to announce the following deaths:

Mr. T. S. Brandegee, honorary curator of the herbarium of the University of California, on April 7, aged eighty-two years.

Prof. Heinrich Müller-Breslau, professor of statics and building construction at the Technical High School of Charlottenburg—Berlin since 1888, and a fellow of the Berlin Academy of Sciences, on April 23, aged seventy-three years.

## Current Topics and Events.

At the invitation of Mr. L. S. Amery, Secretary of State for the Colonies, a number of scientific men and others interested in scientific exploration visited H.M. Dockyard, Portsmouth, on Saturday last to inspect the Royal Research Ship *Discovery*, on the occasion of the commissioning of the ship for employment in scientific research in south polar regions. The visitors were taken from London by special train direct to the South Railway Jetty in the Dockyard, where the *Discovery* is berthed. Much interest was shown in the scientific equipment of the ship and in the laboratory and other accommodation. Shortly after noon, Mrs. Amery hoisted the blue ensign of the Falkland Islands, to show that the *Discovery* had been commissioned, and simultaneously the expedition flag was run up. After the ceremony, the party adjourned to Portsmouth Town Hall, where luncheon was provided. Mr. Amery, who presided, in proposing the toast of "The *Discovery* Expedition," referred to the steps taken by the Colonial Office to mark off a zone in the Antarctic as definitely under British control, in order to preserve whales in those waters. New Zealand has also established control over a corresponding section in the Ross Sea. The work to be carried out during the expedition is outlined in an article which appears elsewhere in this issue. Every arrangement seems to have been made to ensure the comfort of the members of the expedition and facilitate scientific investigation in many fields. We believe that this is the first time that a vessel has been described as a "Royal Research Ship," and we hope that it may be followed in due course by other vessels similarly equipped for oceanographic investigations. We cannot be otherwise than grateful that the conditions under which work will be carried on in the *Discovery* are so different from those afforded to Huxley when he went to Australian waters in the *Rattlesnake* nearly eighty years ago.

In his discourse at the Royal Institution, on Friday June 12, on Faraday as a chemist, Sir William Pope reminded his hearers that Faraday devoted his life to experimental research in chemistry and physics in the Royal Institution, and, at his death in 1867, he was mourned as one of the greatest natural philosophers of the early part of the nineteenth century. Faraday made his advent as a scientific investigator at a moment when striking advances in chemistry were imminent and were indeed to be foreseen; the work of his immediate predecessors, Lavoisier, Davy, Dalton, Berzelius, and Avogadro, had made of chemistry an exact science, and such a genius as Faraday was needed for the development of experimental methods. He worked on a variety of chemical subjects for several years, and on June 16, 1825, laid before the Royal Society the results of his study of the liquid deposited from compressed oil gas, in the course of which he had discovered the compound of carbon and hydrogen now known as benzene. At this centenary of his discovery we celebrate the anniversary of the initiation of a large branch of organic chemistry which in later years became of

great scientific importance and, in addition, became the foundation of the several vast industries. Among these latter are to be numbered not only the manufacture of coal-tar dyes but also important sections of the pharmaceutical, photographic, and petroleum industries. Faraday was the first to make a quantitative study of the chemical changes which result from electrical action, and discovered certain electrochemical laws which are of profound chemical significance. He also carried on numerous investigations on optical glass, steel alloys, the transparency of very thin sheets of gold, and the so-called colloidal solutions of metallic gold in water.

On June 16, the centenary of Faraday's discovery of benzene was celebrated at a full gathering in the historic lecture-theatre of the Royal Institution. His Grace the Duke of Northumberland presided, and in his opening remarks directed the attention of the rising generation to the motives which had inspired Faraday's life, to his profound trust in facts of observation and to his scientific use of the imagination. Although manufacturers have come to recognise the value of such work as Faraday's, in government circles there is still failure to link up scientific methods and discoveries with the public service. His Grace then presented diplomas of honorary membership of the Royal Institution to Prof. E. Bertrand (Paris), Prof. E. Cohen (Utrecht), Prince Ginori-Conti (Italy) (through his representative Dr. G. A. Nasini), Prof. J. F. Norris (Boston), and Prof. G. Sakurai (through Prof. M. Katayama), who were introduced individually by Sir Arthur Keith, secretary of the Institution. Appreciations of Faraday's work were delivered by Prof. H. E. Armstrong, who dealt mainly with the organic chemical aspect, and Prof. Ernst Cohen, who spoke as a physical chemist. Prof. Armstrong stated that the committee organising the celebration had decided to award at intervals—perhaps sexennially—a medal for conspicuous achievement having some relation to Faraday's discovery of benzene. The first award would be made to Mr. James Morton, of Grangemouth, for distinguished work in connexion with the manufacture and applications of anthracene dyestuffs.

FOREIGN delegates of scientific societies were then received by the president of the Royal Institution, the list (a long one) including Prof. E. Bertrand, who read an address, and M. Paul Kestner (France), Profs. J. F. Norris and E. Bartow, Dr. Trowbridge (U.S.A.), Prof. F. Swarts (Belgium), Profs. von Romburgh and E. Cohen (Holland), Dr. Schedler (Switzerland), Prof. M. Katayama (Japan), Dr. G. A. Nasini (Italy). An address was also received from Finland, and Sir William Pope represented the federated chemical societies of Spain. The home societies sending representatives and addresses were the Royal Society (Prof. J. F. Thorpe), Chemical Society (Sir William Pope), Society of Chemical Industry (Mr. W. J. U. Woolcock), Association of British Chemical Manufacturers (Mr. J. Milne Watson), Society of Dyers and Colourists (Mr. E. Hickson),

Faraday Society (Prof. F. G. Donnan). Congratulatory messages were received from the Institute of Chemistry, Indian Chemical Society, various South African societies, Australian Chemical Institute, and (the youngest society) the Auckland Chemical Society. In conclusion, Lord Balfour paid an eloquent tribute to the memory of Faraday, praising in particular his theoretical views on the constitution of the material universe, and expressing his conviction that work of the kind done by Faraday is of far greater value to humanity than the transient labours of the politician. In conclusion, His Grace the Duke of Newcastle thanked the delegates for their presence and for the addresses presented, and Prof. H. E. Armstrong for his work as chairman of the organising committee.

REPLYING in the House of Commons on June 10 to a question as to large scale schemes for eliminating tsetse-flies from British possessions in Africa, Mr. Ormsby-Gore, Under-Secretary of State for the Colonies, drew a necessary distinction between two different proposals. While both schemes are directed towards the early removal of the menace of trypanosomiasis, now overshadowing vast areas of tropical Africa, they are different in scope. To the contemplated international scientific expedition to Uganda, recommended by the International Conference on Sleeping Sickness, held in London last month under the auspices of the League of Nations, we hope to return at an early date. The other project is in no way connected with the League of Nations, but owes much to the energy and enthusiasm of Mr. Ormsby-Gore himself, as shown by the recent Report of the East African Commission, which, under his leadership, visited the British East African Dependencies in the autumn of last year. Briefly stated, what is proposed is to stimulate public interest, and hasten the control of sleeping sickness, and the no less important *nagana* of domestic animals, by speeding up and reinforcing existing methods of attacking the tsetse-fly carriers of these diseases. To this end, it is hoped that it may prove possible to arrange for the appointment of a commission of experts, which shall proceed to tropical Africa for the purpose of undertaking (a) complete surveys of all tsetse areas; (b) further research into the bionomics of tsetse, including the factors controlling increase or decrease; and (c) experiments on a field scale in exterminating these flies. Provided that, pending the issue of the findings of such a commission, the work of which must necessarily be protracted, local governments continue to press forward existing methods of attack, the scheme merits cordial welcome and support.

THE subject of tsetse-fly control received further attention at a meeting of the second Imperial Entomological Conference, held in the rooms of the Geological Society, Burlington House, on the morning of June 15, when the chair was taken appropriately by Mr. Ormsby-Gore. On this occasion a valuable paper entitled "Co-ordination of Effort in Tsetse-fly Investigations" was read by Prof. Warrington Yorke, of the Liverpool School of Tropical Medicine, whose position as one of the foremost authorities on sleep-

ing sickness is universally recognised. Prof. Yorke appealed for organisation to ensure continuity and co-ordination of work, and gave details of an interesting experiment in game exclusion, with reference to its effect upon the local tsetse-fly, *Glossina tachinoides*, now being conducted by Dr. Ll. Lloyd in a small area in Northern Nigeria. In the subsequent discussion, which was both interesting and animated, a number of leading workers on the subject took part, including Dr. Andrew Balfour, Dr. A. G. Bagshawe, Prof. Robert Newstead, Dr. Guy Marshall, Major E. E. Austen, Mr. C. F. M. Swynnerton, Mr. D. W. Scotland, and the chairman.

SIR RAY LANKESTER and Dr. J. W. L. Glaisher were both elected into the Royal Society on the same day, namely, June 3, 1875, so that they have both completed fifty years of fellowship. We understand that the council of the Royal Society has offered congratulations to each of them on their long association with the Society. They are the two senior fellows of the Society next to Sir W. Boyd Dawkins, who was elected in 1867. Sir Ray Lankester received the Copley Medal in 1913, and it is a curious coincidence that in the same year the Sylvester Medal was given to Dr. Glaisher, and hence zoology and mathematics were again through this circumstance in couple. Moreover, they were both at St. Paul's School together. At the time of their respective elections Sir Ray was a fellow and lecturer of Exeter College, Oxford, while Dr. Glaisher was an assistant tutor and examiner in Trinity College, Cambridge. Apart from Sir Ray Lankester's special scientific researches, and not least, those researches which he has inspired in others, and of which he has witnessed the fruition, he has the brilliant gift of literary expression, and has used it to supply the so-called "man in the street" with highly instructive and informative popular descriptions of natural objects and phenomena without loss of scientific dignity. He never, indeed, pandered to the purveyor of "marvels." We may recall that Sir Ray was Director of the Natural History Departments of the British Museum, 1898-1908. He is a corresponding member of the Paris Academy of Sciences, of the Reale Accademia dei Lincei, Rome, and of the U.S. National Academy of Sciences. Dr. Glaisher is a fellow of Trinity College, Cambridge. In his own department of pure mathematics he has done work of supreme value.

THE announcement has been made by foreign correspondents of the daily papers that Prof. Walther Nernst is reported to have communicated to the Berlin Academy of Sciences an account of the discovery of two new elements. It is stated that the new elements have been detected chemically and spectroscopically in several minerals and notably in platinum ores, and that their atomic numbers are 43 and 75. They have been named "masurium" and "rhenium," after the names of the East Prussian borderland and the Rhine respectively. At the time of writing, no details of the methods employed are available and it is impossible to assess the value or importance of the discovery. The new elements

would fall in Group VII. of the Periodic Classification and in a family of which only one member, manganese, has hitherto been known.

THOUGH there were railways long before the Stockton and Darlington Railway and many locomotives before Stephenson's *Locomotion*, the Stockton and Darlington was the first public line and the *Locomotion* the first passenger engine. Newcomen's steam engine owed its birth to the demand of the mines for an efficient pump, and it was in the mines the railway and the locomotive were first developed. The Darlington to Stockton line as originally projected by Edward Pease in 1817 was chiefly for the conveyance of coal to the sea-board, and it was due to the advice of George Stephenson in 1823 that powers were obtained for carrying passengers. This pioneer line was opened in September 27, 1825, when Stephenson's famous engine *Locomotion*, driven by Stephenson himself, drew a train of 34 vehicles with 450 passengers from Darlington to Stockton. Thus was inaugurated the tremendous passenger traffic of to-day. The centenary of this event is being celebrated on an appropriate scale, and on July 1 the Duke of York is opening an exhibition at Darlington. On the following day, *Locomotion* will again be put under steam and will haul a replica of the original train along the line. There is also to be a procession of rolling stock. The celebration has been advanced from September to July on account of the meeting in London during the last week in June of the International Railway Congress. Some 800 delegates representing the railways of the world are attending the Congress, and after the various meetings in London and the district the delegates will proceed to Darlington, when the procession of old and modern locomotives and rolling stock will be repeated. The members of the Institution of Mechanical Engineers will also take a part in the celebration. Stephenson was the first president of the Institution, and the summer meeting is therefore to be held at Newcastle while the centenary celebrations are in progress.

IN the colonial possessions of Great Britain and France the same problems of malaria and sleeping sickness are encountered. British workers are well acquainted with the conditions in their own colonies, but often little is known of those which prevail in the colonies of our neighbours. The two lectures delivered by Prof. Émile Brumpt, of the Faculty of Medicine of Paris, on behalf of the Chadwick Trust, have afforded to medical men in England an opportunity of hearing the views of a distinguished Frenchman on the question of prophylaxis against these two diseases. As was to be expected, the plans of a campaign as outlined by Prof. Brumpt are the same in whatever country it is undertaken, but the instructive series of lantern slides, the outcome of recent tours made by him, illustrated the conditions which conduce to the spread and persistence of malaria and sleeping sickness in countries which rarely come into the experience of British workers. In this respect the lectures were of value in showing that, though the fundamental principles of prophylaxis are always the

same, they have to be applied with due regard to the local features of the country and the habits of the natives. Not only is it necessary for the medical officer to have a good knowledge of the diseases themselves and the parasites which cause them, but he must also understand the bionomics of the insect vectors, which vary with the localities to be dealt with, and, above all, he must be able to modify, extend, and adapt the measures to meet ever-varying contingencies. It results that a sound training in the methods of prophylaxis in all its aspects is a *sine qua non* of success. Furthermore, the control of these diseases is an undertaking which must be made by all the colonising nations working to the same end. Progress made in one colony would be very largely frustrated if the diseases were allowed to run riot in an adjoining territory. In this direction of co-operative endeavour the Health Section of the League of Nations has undertaken the arrangement of an international commission to investigate certain problems connected with the spread of sleeping sickness in Africa, with the view of furnishing information which will be of value to all those nations which are attempting to stamp out the disease.

A BRILLIANT spell of fine summer weather has occurred generally over England, and in the southern and midland districts some unusually high temperatures for June have been experienced. The burst of heat set in on Wednesday, June 3, with a shade reading of 73° at Greenwich and a temperature above 150° in the sun's rays. On Saturday, June 6, the shade temperature was 84°, and the mean temperature for the 24 hours was 11° in excess of the normal. The highest temperature in London at the time of writing was on Thursday, June 11, when 87° was registered at Greenwich, which, however, was beaten for the corresponding day by 2° in 1900, when 89° was registered. A temperature of 90° was registered at Greenwich on May 22 and 24, 1922, which is the highest temperature on record to June 15 since 1841. During the 84 years from 1841-1924, the absolute maximum temperature for the several days in June has occurred on 55 per cent. of the days in the 28 years 1841-68, on 20 per cent. in the 28 years 1869-96, and on 25 per cent. in the 28 years 1897-1924. To Saturday or Sunday, June 13 or 14, there were at several places in the south of England 14 consecutive days without rain, which constitutes a drought. Brilliant sunshine was an exceptional feature in the southern and midland districts.

THE recently issued report of the Empire Cotton Growing Corporation for the year ending on March 31 still shows an excess of income over expenditure, but one which is being steadily diminished, as that body is gradually, through its training of men at the universities and elsewhere, overcoming the great difficulty of providing officers with the necessary technical training to assist in the development of cotton overseas. Nineteen men have now been trained, of whom all but two have received appointments. For the present year, as for last, an unlimited number of studentships is offered to those

who are thoroughly qualified. A grant of 3000*l.* a year is being made to assist in the maintenance of experimental farms in Australia, a plant breeder has been sent to Southern Rhodesia, and another to the Sudan, while, in conjunction with other bodies, funds have been provided for the erection of ginneries in Southern Rhodesia. Many other lines of work are also being commenced. At the present time the production of good cotton within the British Empire is progressing steadily, and is expected to reach 350,000 bales in the coming season. There is no sign yet that the top of the curve is in sight, but much sustained and careful work along scientific lines will be necessary to maintain this development, and to carry it to the point of imperial independence in cotton supply.

At a meeting on June 9, the Illuminating Engineering Society, in co-operation with other bodies interested, held a discussion on "Natural and Artificial Sunlight in Health and Disease." Dr. Saleeby, who opened the discussion, gave an excellent review of this problem, which interests engineers, architects, and medical men alike. There were on view a great variety of special lamps devised to furnish "artificial sunlight." As one of the speakers pointed out, this description is not quite accurate. Nevertheless there is no reason to doubt that such lamps can supplement natural sunlight, with very good results, in medical treatment. Although there has been remarkable gain in our knowledge of effects of light on the human body during recent years, there is much in connexion with the ultra-violet rays, their merits and limitations, that is still obscure. Therefore the view expressed at the meeting that this is essentially a scientific problem, and that such forms of energy should not be applied indiscriminately nor regarded as a panacea for all ills, deserves emphasis. About the general value of sunlight in relation to health there can be little doubt, and every encouragement should be given to efforts to free the atmosphere of our cities from the pollution of smoke from wasteful coal fires. The meeting was a very representative one, and the Society has done good service in bringing together those interested in various aspects of the subject.

THE Council of the British Cast Iron Research Association has recently extended its research programme by arranging for an investigation on the influence of silicon, manganese, and phosphorus on the formation of graphite in cast iron, to be conducted by Mr. M. L. Becker at the University of Manchester, under the supervision of Prof. F. C. Thompson, and for an investigation to be commenced at the National Physical Laboratory, under the supervision of Dr. W. Rosenhain, on the alloy systems iron-silicon, iron-manganese, iron-phosphorus in the presence of carbon over the range usually associated with cast iron. It is anticipated that these fundamental investigations will yield information of great value in connexion with other investigations in hand. The Director and Consultant of the Association are now visiting Continental laboratories and works for the purpose of examining recent foundry developments, particularly in Germany.

At the anniversary meeting of the Linnean Society on May 26, the Society's Linnean medal in gold, its highest award, was presented to Prof. Francis Wall Oliver, professor of botany in the University of London at University College since 1888, when he succeeded his father, Daniel Oliver, in the chair. In presenting the Medal, reference was made to Prof. Oliver's distinguished services,—his work on the fossil Pteridosperms; on the survey of British vegetation, which resulted later in the establishment of the British Ecological Society; his early observations on tidal problems of vegetation at the Bouche d'Erquy in Brittany, followed by the permanent station at Blakeney Point in Norfolk, now the property of the National Trust, under the conditions of the natural flora and fauna being preserved. The Medal has been given in alternate years to a botanist and a zoologist since its institution in 1888, when the centenary of the Society was celebrated.

A CLIMATOLOGICAL congress, arranged by the Davos Institute for Alpine Physiology and Tuberculosis Research, will be held at Davos on August 17-22. Full particulars can be had from the Institute.

At the anniversary meeting of the Linnean Society the following officers were elected:—*President*, Dr. A. B. Rendle; *Treasurer*, Mr. H. W. Monckton; *Secretaries*, Dr. B. Daydon Jackson (General), Dr. W. T. Calman (Zoology), and Mr. J. Ramsbottom (Botany).

DR. E. F. ARMSTRONG, of the British Dyestuffs Corporation, Ltd., and Mr. H. Sutcliffe Smith, of the Bradford Dyers' Association, have been appointed members of the Dyestuffs Industry Development Committee set up under subsection 2 (6) of the Dyestuffs (Import Regulation) Act, 1920, in succession to Sir William Alexander and Mr. G. Douglas, resigned.

At the annual general meeting of the Royal Geographical Society on June 15, the following officers for the ensuing year were elected:—*President*, Dr. D. G. Hogarth; *Vice-Presidents*, Sir Charles Close, Prof. J. Norman Collie, Maj.-Gen. Lord Edward Gleichen, Sir Sidney Harmer, Sir John Scott Keltie, Sir Francis Younghusband; *Treasurer*, Lord Biddulph; *Trustees*, Mr. Douglas W. Freshfield, Lord Ronaldshay; *Hon. Secretaries*, Mr. A. P. Maudslay, Col.-Com. E. M. Jack; *Foreign Secretary*, Sir Maurice E. de Bunsen.

ON Friday, June 26, Viscount Grey of Fallodon will make a presentation to Dr. G. Claridge Druce on behalf of the Botanical Society and Exchange Club of the British Isles, at Dorchester House, Park Lane, London, which has kindly been lent by Sir George and Lady Holford. Particulars of the meeting can be obtained from the Hon. Mrs. Adeane, 1 Dean Trench Street, Westminster.

THE fourteenth International Geological Congress is to be held in Madrid during May and June 1926. The provisional list of subjects for general discussion includes the following topics: The world's reserves of phosphates and pyrites, geology of the Mediterranean and of Africa, Cambrian and Silurian faunas, Tertiary vertebrates and foraminifera, Hercynian

folds, modern theories of metallogeny, vulcanism, and the application of geophysical studies to geology. Excursions covering a wide range of interests are being arranged. The general secretary for the Congress is Señor E. Dupuy de Lôme, Geological Institute of Spain, Plaza de los Mostenses 2, Madrid

THE Albert Medal of the Royal Society of Arts for the current year has been awarded by the Council, with the approval of the president, H.R.H. the Duke of Connaught, to Lieut.-Colonel Sir David Prain, "for the application of botany to the development of the raw materials of the Empire." Sir David is one of the most distinguished of living botanists. When Director of the Royal Botanic Gardens at Calcutta he developed the Government cinchona plantations of India, and organised a system for the cheap distribution of quinine through the post offices, thereby making the drug familiar in every village of India and saving unnumbered human lives. Afterwards, as Director of the Royal Botanic Gardens at Kew, his work was of great scientific importance and of great value to those engaged in the timber and plant products industries.

THE Faraday Society will hold a general discussion on "Photochemical Reactions in Liquids and Gases" at Oxford on October 1-2 next. The subject will be discussed under two main heads: (1) Einstein's Law of Photochemical Equivalence, (2) the Mechanism of Photochemical Reactions. Part 1 will be opened by Prof. A. J. Allmand (King's College, London) and Part 2 by Prof. M. Bodenstein (Berlin). In addition to the leading English workers on photochemical action, many distinguished investigators from the continent and the United States have signified their intention of taking part in the proceedings, and an attractive programme of papers has been prepared. It is hoped to accommodate all who attend the meeting at Exeter College and Lincoln College. Non-members of the Faraday Society may attend the

meeting, and those desirous of doing so are asked to communicate at once with the Secretary of the Faraday Society at 90 Great Russell Street, London, W.C.1, from whom full particulars may be obtained.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Head of the engineering department of the Swindon and North Wilts Technical Institution—The Principal (June 24). A lecturer in electrical engineering at the Municipal Technical College, Swansea—The Director of Education, Dynevor Place, Swansea (June 24). A research worker in the Department of Scientific and Industrial Research, on adhesives—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W. 1 (June 27). An assistant lecturer in mathematics at the Municipal College of Technology, Belfast—The Director of Education, Belfast (June 29). A junior assistant in the Information Bureau of the British Cotton Industry Research Association—The Director, Shirley Institute, Didsbury, Manchester (July 4). A junior assistant in the metallurgy department of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (July 4). A lecturer in physics and mathematics at the Northampton Polytechnic Institute—The Principal, St. John Street, E.C.1 (July 6). A lecturer in physics in the University of Durham (Durham Division)—The Head of the Department of Pure Science, South Road, Durham (July 11). A junior assistant (physics) at the Shirley Institute, British Cotton Industry Research Association—The Director, Shirley Institute, Didsbury, Manchester (July 15). A lecturer in zoology, with special reference to cytology and experimental zoology, in Edinburgh University—The Secretary (July 23). A lecturer in biology at the Cheshire School of Agriculture—The Principal, Reaseheath, Nantwich. An evening lecturer in bacteriology at Battersea Polytechnic—The Principal.

### Our Astronomical Column.

COMET TEMPEL (2).—Information has been received from the International Astronomical Union Bureau at Copenhagen that this comet has been detected by Mr. Stobbe (observatory not stated), as follows:

	G.M.T. (?)	R.A.	N. Decl.
June 11	23 <sup>h</sup> 42 <sup>m</sup> 0 <sup>s</sup>	18 <sup>h</sup> 23 <sup>m</sup> 28 <sup>s</sup>	0° 13'

The magnitude is stated as 12.0, which is fainter than anticipated, and hence explains why it has not been found by the several observers in England who have looked for it. It is approaching the earth and the sun and should brighten considerably. The perihelion date will be about August 7.6, which is within two days of the anticipated date. The following are two predicted places (approximate) for midnight (0 hr.).

	R.A.	S. Decl.
June 18	18 <sup>h</sup> 25.8 <sup>m</sup>	0° 46'
" 26	18 <sup>h</sup> 28.7 <sup>m</sup>	2° 55'

PROVISIONAL SOLAR-CONSTANT VALUES.—Vol. 77, No. 3 of the Smithsonian Miscellaneous Collections contains provisional solar-constant values for the period August 1920–November 1924, together with monthly and decade means from 1918. It is stated by the compilers, Dr. C. G. Abbot and his colleagues, that

they would have preferred not to make public any provisional values at present, as the variation of the sun is seldom large and there is a great difficulty in maintaining a sufficiently high standard of accuracy in the solar measurements to give the magnitudes of the changes very closely. Owing, however, to the growing interest in the "variable" nature of the sun's output in radiation and its promise of usefulness in connexion with weather reports for the study of the dependence of weather and climates on these variations, the demands for the observations have been so insistent that the authors now "publish briefly at this time the best knowledge we now have." The reader is, however, given to understand that small modifications will probably be made in the final publication, which they hope to make in Volume V. of the *Annals of the Astrophysical Observatory*.

Table I., covering 25 pages, gives a summary of the results from Mt. Harqua Hala and Montezuma, while Table III. gives the decade and monthly mean solar-constant values 1918 to 1924. Several interesting curves are given, one of which shows that increased solar activity brings higher solar-constant values.

## Research Items.

**THE RELIGION OF THE PRIMITIVE HUNTER.**—In the *Sociological Review* for April, Mr. Christopher Dawson, in a communication on "Religion and Primitive Culture," argues that the remarkable resemblances in the "hunting cultures" of North America and Siberia, Australia and South Africa, to the culture of palæolithic Europe are too great to be fortuitous. They have a common religious foundation, a common attitude to life which may be called the "religion of the hunter." The fact that totemism extends from West Africa to North America, and was one of the constituent elements in predynastic culture in Egypt, is fatal to the claim of Australia to be the home and centre of diffusion of totemism as held by some writers, and makes it difficult to believe with Prof. Elliot Smith and his school that it was diffused by the historic Egyptians of the "Archaic Civilisation." Judging by the North American evidence, it seems clear that the religion of the hunter—the belief in animal guardian spirits—lies at the root of the whole development. First came the guardian spirit of the Shaman; then of the individual, and as population increased and the group became more complex, the same idea became the principle of the social organisation, on one side of the secret society with a common guardian spirit, on the other of the totemic clan, a group of kinsmen inheriting a common guardian spirit.

**THE MAGIC OF COLOUR.**—Mr. Stewart Culin, in a lecture delivered to the Textile Color Card Association of New York in February last, which is published in the *Brooklyn Museum Quarterly*, vol. 12, No. 2, describes some of the magical beliefs relating to colour, especially in China and Japan. The significance of colour with the fundamental associations, which have come down to our own day, was established when a belief in magic was universal. This applied in five directions, the seasons, the elements, the planets, the points of the compass, and the notes in the musical scale. In an old Korean book in Mr. Culin's possession, the musical notes are indicated in colour. The Chinese flags of the Manchu bannermen, green, red, white, black, and yellow, correspond with the east, south, west, north, and middle. Red is the colour for expelling demons and preponderates in the garments of European peasants, and this colour is used in the placards which the Chinese paste on their doors at the New Year. Yellow was the colour of the middle, of the element earth, of Saturn, of gold, of the grain rice, and of the emperor. Colour determined the value of gold, of precious stones, and turquoise and jade. In Japan colour flourished chiefly in Buddhist ceremonial and in the Imperial court; but the accessories of Shinto are without colour, and the Japanese of to-day dislike Chinese colour.

**THE BLUE WHALE.**—Sir Sidney Harmer (*Proc. Zool. Soc.*, 1923, p. 1085) contributes some interesting observations on two enormous cervical vertebrae of the blue whale, found in the Panama Canal Region and presented to the British Museum by Mr. F. Mitchell-Hedges. These vertebrae had the epiphyses completely fused, and this fact, coupled with their large size, when compared with available evidence from other specimens, bears out the original estimated length of the specimen of ninety-eight feet. This would appear to establish the fact that the northern blue whale may grow to at least one hundred feet, and that there is no substantial basis for the suggestion that the southern race of this whale is larger than

the northern. As the blue whale is considered an ice-loving species, this record from the tropics is of considerable interest from that point of view, as well as from its bearing on the possibility of a migration across the equator of blue whales from the northern to the southern hemisphere, and vice versa. Further evidence of the size at which the epiphyses in this whale become ankylosed is supplied by Sir Sidney in *Proc. Zool. Soc.*, 1924, p. 1175. In the southern race of the whale specimens measuring eighty-four feet were found to have the epiphyses free, while in one of ninety-one feet they were fully ankylosed.

**BEAKED WHALES.**—In *Proc. Zool. Soc.*, 1924, p. 541, Sir Sidney Harmer reviews the genus *Mesoplodon*, with special reference to *M. mirus* and *M. densirostris*, and discusses the cranial characters of the beaked whales in general, with a valuable criticism of the importance of the antorbital region of the skull as a valuable character for purposes of classification. He rejects the genus *Paicea* of Oliver as instituted on insufficient grounds, and includes it as a synonym of *Mesoplodon*. Detailed descriptions of two skeletons of *M. mirus* from the coasts of Ireland (two out of the only three known specimens) and one of *M. densirostris* from Madeira conclude a valuable contribution to our knowledge of Cetacea. Sir Sidney Harmer's ninth report on Cetacea stranded on the British coasts covers the years 1923-24, and, while not including any species of great rarity, several interesting records are deserving of notice. The white-beaked dolphin was more numerous than usual, and appears to be establishing its claim to be regarded, after the common porpoise, as the commonest British cetacean. Special attention is directed to the record of the false killer (*Pseudorca crassidens*) in a sub-fossil condition in the Cambridgeshire Fens, and to the unexplained occurrence of vertebrae of three large rorquals (two blue whales and one common rorqual) off Newhaven, Sussex.

**MOSQUITO CONTROL.**—The International Health Board of the Rockefeller Foundation has issued a very valuable pamphlet on "The Use of Fish for Mosquito Control." It includes a brief historical survey of the matter, a very complete summary of the work which has been accomplished in all parts of the world, with illustrations of the fish employed, and a general statement of the biological principles on which the control of mosquitoes by fish is based. Special attention is given to the requirements of fish as mosquito destroyers, and to the conditions under which they may be successfully used for this purpose, emphasis being laid on the use of indigenous species where possible. It is intended mainly for the use of the field staff of the Board, but has obviously a wider field of interest, and the biologist particularly will welcome this full statement of the results which have led to the elaboration of this method of controlling yellow fever and malaria, and to its successful establishment in various parts of the world.

**A NEW PROLIFERATING LARVAL TAPEWORM.**—B. Schwartz describes (*Proc. U.S. Nat. Mus.*, vol. 68, art. 24, 1924) cysticeri, which he refers to a new species of *Tænia*, from the lung of an Alaskan porcupine (*Erethizon epixanthum*). The cysticeri occur singly or in colonies; in the latter case the basal stalks or peduncles issue from larger stalks which are in the lung tissue. The scolex has four elliptical suckers and a double row of hooks—18 large and 18 small.

MYCETOZOA OR "POLYANGIDÆ."—Roland Thaxter in 1892 first described as Myxobacteria, primitive minute organisms which in the vegetative state, though retaining their separate individuality, radiated outwards as they multiplied on the substratum, as a slimy plasmodium-like mass. As their name suggested, Thaxter thought the individual organisms, multiplying probably by transverse fission, were allied to the bacteria, the whole mass in its slimy aggregate recalled the plasmodium of the Myxomycetes (or Mycetozoa). Jahn has recently reclassified the group, adding new forms that he has first described ("Beiträge zur botanischen Protistologie." 1. Die Polyangiden. Leipzig: Gebrüder Borntraeger, 1924. 10s. 6d.), and, not satisfied with the affinities suggested by Thaxter's name for the group, rechristens them the Polyangidæ, after the generic name under which a species of the group was first recorded (in 1809). Thirty-six species are now described under eleven genera, which are grouped in four families. The systematic characters are mainly based upon the form and structure of the very small, but sometimes very striking fruit bodies, into which the slimy mass of microscopic organisms aggregate themselves under suitable conditions, though the family regarded by Jahn as most primitive only heaps into irregular masses, never forming definite cysts.

STARCH AND OTHER CELL-CONTENTS.—The Mémoires de la Société Royale des Sciences de Bohême for 1923, published at Prague (1924), contains a number of papers, mainly mathematical and botanical; they are written in Czech or German and followed by a summary in French or English. Several botanical papers are systematic or ecological in nature. In addition, W. S. Iljin describes further experiments dealing with the effects of salts upon the hydrolysis of starch (NATURE, September 15, 1923, p. 407). Sodium chloride in concentrations from 0.05 M to 0.1 M causes the hydrolysis of the starch in the guard cell of stomata in many plants, but in the case of halophytes much higher concentrations are necessary. Vegetable cells placed in dilute solutions of maltose synthesise starch energetically, but the process is stopped by the addition of sodium chloride or other salts to the solution. E. Votoček and V. Ettel direct attention to the ease with which galactose yields a crystalline dibromo, 2.4-phenylhydrazone, thus permitting its quantitative separation under certain conditions from xylose, rhamnose, glucose, fructose, etc., but not unfortunately from arabinose, with which it is so often associated after hydrolysis of plant pectins.

THE FUNCTION OF NICOTINE IN THE PLANT.—J. J. Theron and J. V. Cutler have an interesting contribution to this problem, which is of both theoretical and commercial importance, in the *South African Journal of Science*, vol. 21, 1924, pp. 189-194. They show that the total nicotine content in the plant increases up to the flowering stage, after which there is a rapid decline, whilst the formation of seed immediately reduces the percentage of nicotine. They conclude that the nicotine is a storage product which is drawn upon to form other nitrogen reserves within the seed. The authors also record continued metabolic change in the harvested crop which produces a considerable diminution of nitrogen and can be prevented by methods which raise the temperature of the leaves shortly after the crop is cut.

THE GEOLOGY OF THE CHATHAM ISLANDS.—Early last year the Otago Institute organised an expedition to the Chatham Islands, and a preliminary account of the geological observations has now been given by R. S. Allan in the *New Zealand Journal of Science and Technology* (Feb. 1925, p. 290). The Islands consist structurally of a series of faulted

blocks which in the late Pliocene were relatively elevated or depressed to different levels, and have since been eroded, and linked up by immense sand banks and spits. The most southerly block of the main island now rises to nearly 1000 feet and ends suddenly in a magnificent line of basaltic cliffs up to 700 feet in height. The northern part of the island is low-lying and swampy, but here the oldest rocks, quartz-mica-schists striking approximately east and west, are exposed along the shores. Lithologically these schists resemble those of Otago, but the comparison throws no light on their age, as the Otago schists themselves have been referred to various periods from the early Palæozoic to the early Mesozoic. Lying on the foundation stones of the Islands with great unconformability are Bryozoan limestones and limburgite-tuffs of Oligocene age. Unconformably on these are Middle Pliocene sands and grits containing a fauna, 63 per cent. of which is identical with that of corresponding age in New Zealand. The Oligocene limestones, in striking contrast, have only 4 per cent. of the species in common. The volcanic rocks are of great interest and are referred to two main epochs of eruption. The earlier series (Oligocene) consists solely of tuffs and flows of limburgite. The later series (younger than the Oligocene and older than the late-Pliocene or Pleistocene fault-movements) is mainly made up of basalts, but associated with the predominant type are mica-andesite, trachyte, and phonolites.

ORIGIN OF PLATINUM AND GOLD NUGGETS.—Detailed physico-chemical analyses of platinum nuggets have enabled Prof. S. F. Zhemchuzhny (*Ann. Inst. d'analyse physico-chimique de l'Acad. de Science de Russie*, vol. 1, liv. 2) to come to the conclusion that the nuggets do not differ in their structure from alloys. Certain details of structure, as well as the presence within the mass of platinum of crystals of osmic iridium and of small round cavities, corresponding to bubbles of air, show that platinum has crystallised from the magma in which it has been dissolved in a molten condition. Gold nuggets, according to the same author (*loc. cit.* 2, liv. 1), are of a quite different origin, their structure and physical properties indicating that they have been formed by crystallisation of gold from solutions of that metal in the water solutions of sulphur salts or of sulphates of iron oxide, which are products of oxidation of gold-containing sulphur pyrites.

THE POLAR AURORA.—Prof. L. Vegard has recently shown by means of experiments made with solidified nitrogen diluted with argon at the temperature of liquid hydrogen, that it was possible to reproduce the  $N_1$  aurora line by bombardment with cathode rays. In collaboration with Messrs. H. Kamerlingh Onnes and W. H. Keesom he describes in the *C.R. Acad. Sci.*, Paris, April 6, experiments in which the nitrogen was diluted with neon, and cooled with liquid helium. The  $N_1$  band changes, when the proportion of neon is increased, in a similar manner to that observed with nitrogen and argon at the temperature of liquid hydrogen, but with a much slower displacement towards the red as the dilution is increased; the position of the principal maximum, indeed, remains nearly constant until 70 per cent. of neon is present. From this point on, the maximum commences to shift rapidly with an increase in the proportion of neon, on account of the resulting diminution in the size of the nitrogen particles. When the proportion of nitrogen has been reduced nearly to zero the  $N_1$  band becomes a line, with wave-length 5578.6, which very nearly coincides with the green line of the aurora. The small difference is attributed to a specific action of the neon,

so that it is probable that, if similar small particles of nitrogen could be bombarded with electrons at very low temperatures without any additional substance, the auroral green line would be given out.

**THE DENSITIES OF LIQUID AND GASEOUS HELIUM.**—When the densities of a gas and of its liquid form, in contact with one another, are plotted against temperature, the two density curves meet at the critical temperature, the joint curve being roughly parabolic. If now the arithmetic means of the two densities at the different temperatures are plotted, the graph has been found to be nearly a straight line, which also passes through the critical point. In the *C.R. Acad. Sci.*, Paris, March 30, E. Matthias, C. A. Crommeln, H. Kamerlingh Onnes, and J. C. Swallow give the results of a series of measurements which verify this law of the rectilinear diameter for helium, the densities having been measured for nine temperatures ranging from  $4.71^\circ$  abs. down to  $2.30^\circ$  abs. The deviations from rectilinearity are small, but a little larger than for hydrogen and neon. By means of the equations deduced it is possible to calculate the value of the critical temperature of helium  $\theta = 5.19^\circ$  abs., and the critical density  $\Delta = 0.06930$ . The critical coefficient  $R\theta/\Pi$  is equal to 3.270, where  $R$  is the gas constant and  $\Pi$  the critical pressure, this is very nearly the same as for hydrogen (3.276).

**DIRECTION OF RADIO SIGNALS DURING THE ECLIPSE OF JANUARY 24.**—Prof. Merritt communicates a paper on the changes observed in the direction of radio signals at the time of the eclipse on January 24, 1925, to the April number of the *Journal of the Franklin Institute*. As a part of the programme of eclipse observations at Ithaca, N.Y., records were kept during the morning hours of January 23, 24, and 25 of the apparent directions of stations at Schenectady and New York as indicated by radio direction finders. Graphs are given in this paper of the results obtained. The observations were begun at least an hour before sunrise, and show in a striking way the large and extremely rapid changes in direction characteristic of night conditions. The time at which "day conditions" are established seems to vary largely from day to day. On the day of the eclipse, the night conditions persisted until an hour after sunrise, and this although the sun had been shining brightly. On the next day, which was very cloudy, day conditions were reached while it was still almost as dark as midnight. It is concluded that if the observed direction changes are due to sunlight at all, they must be brought about by the changes caused by light in the upper regions of the atmosphere. Although the variations in the direction during the early hours of January 23 were much less marked than on January 24, yet there is a definite indication that night conditions persisted nearly as long on both days, although January 23, like January 25, was a very cloudy day. There is some slight evidence that persistence of night conditions after sunrise is associated with high barometric pressure and a large pressure gradient. On the day of the eclipse, night conditions persisted until half an hour after the eclipse began. Six minutes after the end of totality a systematic drift towards the south began, and for eight minutes the settings indicated that the signals were coming from a direction  $15^\circ$  south of the true direction of New York. Thirty-five minutes after totality, the readings had become normal. It is stated that if the effect is due in some way to changes in the ionic concentration resulting from changing illumination in the upper atmosphere, then the delay in the appearance of an eclipse effect until after the end of totality might have been expected.

**SEPARATION OF SELENIUM AND TELLURIUM.**—V. Lenher and C. H. Kao describe a new method of separating selenium and tellurium in the *Journal of the American Chemical Society* for March. To a solution of the oxides in 100 c.c. of concentrated hydrochloric acid, 50 c.c. of acid saturated with sulphur dioxide is added. After vigorous stirring, and on standing, selenium settles out and is readily filtered off. The tellurium is then obtained from the mother liquor by precipitation with sulphur dioxide and hydrazine. The temperature of the solutions should never exceed  $30^\circ$ .

**CONDUCTIVITY IN SOLUTION AND CONSTITUTION.**—The conductivities of many saturated salt solutions in liquid hydrogen sulphide at the temperature of solid carbon dioxide have recently been measured by G. N. Quam and J. A. Wilkinson (*Journal of the American Chemical Society*, April). Many salts form conducting solutions; halides of the phosphorus family show increased conductivity with increase of atomic weight, except in the case of bismuth, which forms an insoluble compound with liquid hydrogen sulphide. The conductivity of solutions of acetic acid derivatives is higher the greater the negativity and positivity of the groups joining the compound. Ammonium chloride is insoluble in the solvent; the introduction of alkyl groups in place of hydrogen causes the compound to become soluble and the solution conducts in proportion to the number of groups introduced. Pure liquid hydrogen sulphide has a conductivity less than  $1 \times 10^{-11}$  reciprocal ohms.

**A CONTINUOUS REFRIGERATOR.**—Refrigerating plants may be broadly grouped into the vapour compression type and the vapour absorption type. Vapour absorption machines are generally intermittent in action, since the ammonia has to be expelled by heat from a solution in one stage of the cycle and absorbed back again in a later stage. These operations necessitate the manipulation of valves. In the issue of the *Machinery Market* of May 1, there is a description of a novel method of continuous refrigeration, working on the vapour absorption system, which is the invention of two Swedish engineers, Munters and Platen, and for which they were awarded the Polhem Medal in 1924. The Munters-Platen system has no moving parts and the pressure is the same through the circuit. The evaporator contains a strong solution of ammonia. At the base of the evaporator is a heater round the body of which is coiled a pipe which projects above the surface of the liquid. When heat is applied this pipe becomes so hot that the solution inside it boils, and rising, discharges water into the evaporator, the ammonia gas being liberated. The ammonia solution is drawn from an absorber into the evaporator by this novel thermo-syphon device which induces automatic circulation. The ammonia gas given off by the evaporator is passed into a condenser and liquefied. This liquid ammonia then passes into a generator, where it gasifies absorbing heat from its surroundings, thereby producing refrigeration. The ammonia gas from the generator mixes with the hydrogen filling the system. The resultant gas mixture is heavier than pure hydrogen and enters an absorber near the bottom where it meets a shower of water. The water absorbs the ammonia, and the hydrogen, denuded of the heavier ammonia gas, rises and returns to the generator, entering near the top. Thus there is an automatic circulation. The connecting pipes are so arranged as to function as heat interchangers in both the gas and the liquid circuits. The only motive force for the whole apparatus is the heating coil in the evaporator.

The Origin of Species as revealed by Vertebrate Palæontology.<sup>1</sup>

By Dr. HENRY FAIRFIELD OSBORN,

Senior Geologist, U.S. Geological Survey; Hon. Curator Vertebrate Palæontology, American Museum of Natural History; Research Professor of Zoology, Columbia University.

I. JUST as in the inorganic world energy directs matter, not matter energy, so motion or function invariably precedes form; change of motion or function precedes change of form.<sup>2</sup> A static condition of form, in either the trunk, the limbs, the vertebræ, or the teeth, implies a static condition of habit, of habitat, or of function; consequently, a new habit (ontogeny), in either the unchanged or changing environment, gives rise to a new movement or function and results in change of form in the organ most directly affected. Each particular organ and each part of an organ may manifest a dependent or independent change of function and consequent change of form; thus a series of organs or of closely related or similar parts of the same organ may manifest either harmonic or disharmonic change. This principle, first observed by Aristotle, more or less developed by Lamarck, and more specifically by Cope, has been confirmed by such observations as those of Arbuthnot Lane.

II. *The principle of compensation* on economy of growth, first formulated by Aristotle and later more clearly by Geoffrey St. Hilaire (*loi de balancement des organes*), whereby the increased motion or function of one organ is compensated for by diminished motion or function of another organ, is a bio-mechanical principle thoroughly established in vertebrate palæontology; not only adjacent or related organs, but organs widely separated functionally and anatomically rigidly obey this economic law, which receives its most substantial demonstration in palæontologic series. Its corollary is development and perfection through use and degeneration through disuse.

III. *The principle of continuity*, in which evolution is like growth, is one which could be discovered and observed only in palæontology, where large numbers of successive lines of descent of organisms can be observed. To our knowledge, this principle was first observed by the invertebrate palæontologist Waagen in 1869, who observed continuous change whereby a minute and inconspicuous organ gradually in geologic succession becomes so conspicuous as to constitute a stage; he named this stage a "mutation," a term now used in palæontology in a sense directly opposite to its borrowed use in botany and zoology. Following the establishment of the principle of continuity by many invertebrate palæontologists came the vertebrate studies of Déperet and especially of Osborn, who in his monograph of researches on the evolution of the titanotheres<sup>3</sup> has firmly established this principle. Every bio-mechanical organ in every part invariably arises and evolves through a continuous process, and in this respect evolution is a forecast of ontogeny or individual development. Each new adaptive organ rises gradually and continuously out of the germ-plasm, passes into a stage of mechanical perfection, and then subsides into the germ-plasm and disappears.

IV. *The principle of germinal or evolutionary trend in a definite direction*. So far as I know, this was first expressed by the Austrian palæontologist Neumayr, who applied to this trend the term "Mutations richtung," equivalent to "trend of evolution." He applied

it to just such characters of ornament, shell marking, and shell proportion as those observed by his predecessor Waagen in his "mutations." This cumulative orthogenetic trend in evolution of organs in certain definite directions is also firmly established in both invertebrate and vertebrate palæontology. It may be quite antecedent to ontogenetic habit or function and, consequently, by its independence of origin is purely germinal; it is a process resident in the heredity germ itself.

V. *The principle of acceleration and retardation*. Observed by Von Baer in embryology, this principle was formulated and elaborated in palæontology by Alpheus Hyatt, a member of this Academy. It is one of the most important principles in bio-mechanical evolution, as hurrying forward or holding back the development of organs to the exact moment when they are first needed and most needed by the organism. For example, in all hoofed animals of the plains, where the young may be required to run with the mother immediately after birth, the adult limb proportions are pressed back into the prenatal stage so that the young at birth may be able to keep pace with the mother, for a few moments at least. This bio-mechanical principle can only be explained by Darwin's selection principle operating on heritable variations.

VI. *The principle of allometry*, or change of proportion as studied by Osborn in the Titanotheres Monograph.<sup>4</sup> Adaptation through change of proportion is the most universal principle in vertebrate evolution. It is due to three causes: (a) the elongated neck of the giraffe, alternately cited by Lamarck and Darwin as due to inheritance or selection, may be experimentally shown to be due to the deferred inheritance of an acquired adaptation through the coincident selection of all fluctuations in the adaptive direction. (b) All changes of proportion which are not caused by either habit or selection fall under the principle of "Mutations richtung" or evolutionary trend, whether observed in the shells of invertebrates or in the head form of the mammals, including man. (c) All changes of proportion which are influenced by habit are due to this dual mode of accumulation; by experimental adaptation in a single lifetime, e.g. the hind limbs of a dog with proportions of the running type are changed into hind limbs with proportions of the leaping type by the process brought about by the principles of compensation and self-adaptation.

VII. *The principle of rectigradation*<sup>5</sup> in adaptive organs arising from the germ-plasm passing continuously from the most rudimentary into the most efficient and highly developed stages. First observed in the Primates in 1889 by Osborn, this principle has since been confirmed in the other four great orders of mammals, the horses, rhinoceroses, titanotheres, and the proboscideans (Osborn, 1889-1911). Consequent on this principle is the "potential homology" of organs (Osborn, 1902-1911), in contrast with the true homology of Aristotle, or "genetic homogeneity." For example, all the bony elements of the limb of the Tetrapoda are homologous in Aristotle's sense; all except one of the elements in the grinding teeth of the mammals are instances of potential homology rather than of genetic.

<sup>5</sup> Eimer sets forth a graduated evolution as comparable to organic growth. The conception of rectigradation as defined by Osborn is found in Eimer's volume, nor is the word "orthogenesis" attributed to Eimer of the same import as rectigradation. (Eimer-Cunningham, "Organic Evolution as the Result of Acquired Characters," 1890.)

<sup>1</sup> Continued from p. 926.

<sup>2</sup> See D'Arcy W. Thompson, "Growth and Form" (Cambridge, 1917), Chapter I. See Osborn, "Origin and Evolution of Life" (New York, 1916), Introduction.

<sup>3</sup> H. F. Osborn, "The Titanotheres of Ancient Wyoming, Dakota, and Nebraska," United States Geological Survey Monograph, No. 55. Now in press. A sequel to the monographs of O. C. Marsh.

VIII. *The principle of experimental adaptation.* This principle is fundamental; the "trial and error" or experimental impulse as observed in the freely moving Protozoa prevails throughout the animal kingdom and is one of the chief ontogenetic phenomena. Thus many of the higher mammals, especially the equines and the proboscideans, guide their own evolution through initiative and resourcefulness just as man is able to guide his own evolution in adaptation to new conditions of environment and biota. This principle in part accounts for the extraordinary diversity of the mammalian kingdom, which since the close of the Cretaceous has radiated from small rat-like forms into the marvellous diversity of the existing mammalian life, while the Crocodilia and Testudinata remain as they were at the close of the Age of Reptiles.

IX. *The principle of adaptive radiation,* continental, local, oceanic. While all sessile organisms like plants and sessile invertebrates develop superb bio-mechanisms simply in direct reaction to stresses and strains, and while static organisms like the Crocodilia and Testudinata remain in the condition of arrested development through conservation of habit, the freely mobile organisms like the Lacertilia and Ophidia among reptiles, the birds, and all divisions of the mammals enter new ontogenetic and phylogenetic phases through the principle of adaptive radiation (Osborn), which is an elaboration of Lamarck's *ébranchement* and Darwin's "divergence." Repeatedly in all four classes of vertebrates we observe the cycle of terrestrial, fossorial, aquatic, often ending in marine adaptation of the body and limbs. Also terrestrial, arboreal, glissant, and volant forms arise. Meanwhile insectivorous diet may branch into carnivorous or omnivorous on one hand, or into herbivorous or frugivorous, leaf-eating, browsing, grazing adaptations of the general mechanism on the other. Under this principle as developed by Osborn fall the bio-mechanical processes of convergence, the homoplasy of Lankester, and the alternative habitat discussed and elaborated by Dollo. In every instance where we can observe transition from one habitat or from one feeding to another, the adaptive response of the organism to the new conditions is immediate. The response of heredity to new conditions is very gradual. For example, heredity may conserve "palæotelic" adaptations in a "cœnotelic" exterior. In Gregory's language, "heritage" is long concealed by "habitus," but after the passage of very long periods of time cœnotely replaces palæotelically and habitus gives rise to new heritage.

It should be said that, of these nine bio-mechanical principles, five were first observed in zoology and were afterwards confirmed and greatly clarified in palæontology, namely, the principle of function preceding form, the compensation principle of Aristotle and St. Hilaire, the acceleration and retardation principle, the experimental adaptation principle, and the adaptive radiation principle. Four may be observed only in palæontology, namely, the mutation principle of Waagen and the "Mutationsrichtung" of Neumayr, the rectigradation principle of Osborn, the continuity principle of Waagen, Neumayr, and Osborn.

These nine principles are well-substantiated facts; they are not hypotheses or theories. They include the observed modes by which new mutations, new species, new genera, new families, new orders of vertebrates arise in their bio-mechanical evolution. Every particulate organ of the skull, limbs, and teeth develops and evolves continuously in perfect bio-mechanical response or reaction to fixed or changing life environment and habit. The germ-plasm conditioning this bio-mechanical adaptation also evolves continuously, but lags far behind ontogenic adaptation, whether it be to produce the static mechanism of

*Sequoia gigantea* or the mobile mechanism of the sperm whale, *Physeter macrocephalus*, or the no less marvellous mammoth, *Elephas primigenius*. Slowly following in secular time, adaptive reactions to new living environment, to new forms of self-adaptation, there is the onward germinal impulse. The rise of new rectigradations and allometrons in the germ-plasm is not in the nature of vitalism or preformation, but of more or less deferred adaptive reaction to secular experience.

Passing from the boundaries of actual observation, we may point out the bearing of the above nine principles upon some of the current hypotheses and opinions as to the causes of evolution.

It is, for example, frequently stated that environment is the cause of evolution; this is only a quarter truth, as may be seen by consideration of the following eleven observations made in palæontology:

1. *Bio-mechanical evolution* may be as rapid in a fixed physical environment like the ocean as in a changing environment like a continental surface, because bio-mechanical evolution depends as much on living environment (biota), on self-adaptation, on plastic heredity as it does upon physical environment.

2. *As to static heredity*, during the whole changing period of the Age of Mammals, mechanical evolution of two orders of reptiles, the Crocodilia and the Chelonia, was practically arrested, while mechanical evolution of the mammals was extremely rapid. This principle shows that certain animals had a fixed heredity while others had a plastic heredity.

3. *As against Lamarckism* and the Lamarckian hypothesis of the influence of animal intelligence on evolution, mechanical adaptation of the small-brained, cold-blooded reptiles was as great, or greater, during the Age of Reptiles as that of the warm-blooded, large-brained mammals during the Age of Mammals.

4. *As against Lamarckism* which involves the efforts, desires, and movements of animals in mechanical evolution, it may be said that mechanical adaptations in nerveless plants which have no movements or nervous systems are quite as remarkable as are those in the nervous and sensitive and mobile vertebrates. This proves that mechanical adaptation may be quite independent of the nervous system of animals or of the inherited effects of reaction to motion. Nevertheless, as Lamarck believed, all mobile vertebrates, like all human beings, are able to alter the trend of their evolution through the search of new food (biota), through meeting new competitors (biota), through entering new environment by geologic change or by migration (environment), through self-adaptation by new habits (ontogeny).

5. *As against Lamarckism*, in the horse family it is observed that mechanical evolution of the limbs and feet, which are rapidly improved and adapted by habit (ontogeny), is less rapid and less remarkable than the mechanical evolution of the teeth, organs which are entirely preformed by heredity and are destroyed by use and habit in ontogeny. The same is true of the marvellous mechanical evolution of the grinding teeth of the Proboscidea.

6. *As against Darwin's principle* of bio-mechanical evolution through selection and the survival of favourable variations, we observe that the mechanical evolution of the most rapidly breeding animals, such as the rodents, was much less extreme during the Pleistocene time than the mechanical evolution of the slowest breeding animals, the elephants. During the 500,000 years of the Pleistocene period there was an intensely rapid evolution of the dental mechanism of the slow-breeding elephant and little or no evolution in the dental evolution of the fast-breeding rodents.

7. *As against both Lamarck and Darwin*, the principle of rectigradation (Osborn) shows that new

mechanical adaptation organs arise out of the germ-plasm without the antecedent action of self-adaptation. (a) While in all parts of the skeleton the principle of mechanical self-adaptation prevails and new proportions, new characters, new adaptations, new functions, new modes of locomotion may be created in the lifetime of a single individual, all that is transmissible in heredity is the germinal variation to plasticity or adaptability in the desired direction, which may be accumulated through coincident selection as applied by Osborn, Baldwin, and Morgan. (b) Even more perfect mechanical adaptations arise in the grinding teeth which are not perfected during lifetime.

8. *As against mutational or saltatory hypotheses of evolution* hitherto held by Bateson and his school, the principle of bio-mechanical continuity is so firmly established that we may attribute all discontinuity in bio-mechanical evolution to abnormal, unnatural, pathogenic causes or, through recent discovery, to endocrinal disturbance. Whatever may be true in bio-chemical evolution, in colour, in immunity, in metabolism and phenomena of that order, we may be certain that the bio-mechanical evolution of the skeleton and teeth as observed in palæontology assumes and follows its firm and undeviating order.

9. *Bio-mechanical evolution as observed in full palæontological series*, whether vertebrate or invertebrate, gives the death-blow to the chance hypothesis of Democritus and Empedocles raised into a scientific system in the subsidiary fortuitous selection hypothesis of Darwin. Nature is observed to take no chances, either in the transformation of existing mechanical organs or in the origin of new mechanical characters and inventions. New parts of the organic machine arise in rudimentary condition but perfect order out of the germ-plasm when the demand for them arises; they do not arise automatically without an antecedent bio-mechanical stimulus. They play their continuously adaptive service; when no longer useful they subside and sink back into the germ-plasm, where the power of reproduction is ultimately lost.

Every single one of hundreds of bio-mechanical characters of which the evolution has been observed follows the nine principles enunciated above.

10. *The loss of bio-mechanical organs* in the vertebrates is never sudden, as if due to the presence and absence principle of Mendelism. Organs evolved through a long process of continuity show remarkable heritable stability, like longheadedness in man or in the hooved mammals when crossed with broadheaded types. In the horse-ass hybrid, for example, most of the bio-mechanical skeletal characters transmitted are those of the horse, all of which have evolved over a very long period of time—hundreds of thousands of years. Certain of the bio-mechanical characters and most of the psychic characters are those of the ass. Thus a continuity in bio-mechanical evolution may give rise to Mendelian discontinuity in hybridising, exactly as it does in the matter of bio-chemical evolution.

11. *Every race will more or less rapidly lose its typical form* in any one of four ways consistent with the tetraplastic and tetrakinetic principle of Osborn: (a) by alteration of its internal energies of heredity (phylogeny); (b) by alteration of the external energies of environment; (c) by alteration of the external energies of the biota of plant and animal environment; (d) by alteration of the internal energies of habit or ontogeny. Any one of these four energetic changes will immediately precipitate a new action of selection, and as a secular process will alter the germ-plasm.

It appears from these eleven observations that palæontology is a two-edged sword which is equally ruthless in the Darwin-Weismann and the Lamarckian fields of speculation.

In conclusion, what really happens in the natural origin of species in bio-mechanical characters is this: *Whenever all the four energetic conditions of heredity, of environment, of biota, of habit or ontogeny, and the non-energetic condition of the struggle for existence (selection) are the same, there will arise similar ascending mutations, species, genera, families.* New similar or parallel species of hooved animals actually arise at approximately, if not at precisely, the same rate, whether we observe them in France, Mongolia, or the Rocky Mountain region.

My rejoinder to Bateson's statement<sup>6</sup> that "the origin and nature of species remains utterly mysterious" is that thirty-six years of intensive palæontologic exploration and research have so clearly and repeatedly revealed how new bio-mechanical species arise that we can safely predict not only what the species is, but also where it is most likely to be found and in what stage of evolution it will be found. Such prediction has recently been fulfilled in a most brilliant manner in our discoveries of the Titanotheres in central Mongolia. Whatever may prove true as regards species founded on bio-physical or bio-chemical characters, the research is nearly closed on the modes of origin of bio-mechanical species, because we have little more to learn.

The causes of these origins is quite another matter. Some day we may be able to work out the separate contribution of each of the four energetic factors, heredity, environment, ontogeny, biota to germinal evolution. We palæontologists observe exactly how the process of germinal evolution of bio-mechanical characters goes on, adaptive in every stage, just as the embryologists observe how the process of adaptive development goes on whereby the invisible germ turns gradually into the adult and perfected skeleton and teeth. There is no accident in either mode of transformation, evolutionary or developmental, nor is there anything that we can comprehend. On the whole, the order of evolution imitates the order of development; both processes, to our mind, are equally inexplicable, and will probably remain so.

<sup>6</sup> William Bateson's observations on discontinuity in the origin of species first appeared in his "Materials for the Study of Variation," 1894. More recent are his British Association address in Australia and his address at the Toronto meeting of the American Association quoted from above.

### Accuracy of Weighing in the Eighth Century.

TWO recent papers in the *Numismatic Chronicle*<sup>1</sup> contain interesting information on the remarkable accuracy of ancient weighing. Dr. G. F. Hill mentions that in a hoard of 20 gold staters of Lysimachus (c. 355–281 B.C.), in mint state, the extreme weights were 8.62 and 8.42 grams, i.e. the maximum variation was 2.3 per cent. Eleven of the coins, however, had weights with a much smaller range, namely, 8.57 to 8.52 grams, a variation of only 0.58 per

cent. Dr. Hill considers this degree of accuracy to be no greater than might be obtained by cutting a bar of uniform thickness into equal lengths with an ordinary measure. The smallest weight about which the Greeks cared seems to have been not less than 0.05 gram.

Much greater accuracy is shown in certain Arabian glass coin-weights of the eighth century which are described by Sir Flinders Petrie. The average error of dinar and dirham weights of this century is 0.004 gram; in the early weights the accuracy is

<sup>1</sup> G. F. Hill, "The Frequency Table," Fifth Series, vol. 4, p. 76, 1924; W. M. F. Petrie, "Glass Weights," Fourth Series, vol. 18, p. 111, 1918.

even finer. Thus in 780 "the astonishing result of three weights is 32 662, 32 665, and 32 667 grains," or all within a third of a milligram. As Sir Flinders says, "to reach such accuracy it was needful to use the finest chemical balance, with closed case, double weigh the glass weights against each other, and read a long series of swings of the balance. How such accuracy was reached in the manufacture is incomprehensible. Nothing known of any other age at all approaches the fine weighing of the eighth century."

That the Arabs made an intensive study of the balance from both the theoretical and the practical sides, is well known. There is, indeed, a wide literature on this subject, which was considered to be a distinct branch of science. The celebrated mathematician Thābit ibn Qurra (836-901) wrote on the Roman balance or *qarastūn* (χαριστήριον) a treatise ("Kitāb fī'l-Qarastūn") which is still extant (MSS. Berlin, 6023; India Office, 767, No. 7). Other authors who dealt with the theory or practice of weighing are Al-Farabi, Avicenna, Qusta ibn Luqa, and Ibn al-Hartham. Most important of all, however, is the treatise written by Al-Khazini in 1121 for the Sultan Sinjar. "This is not confined to the description of various balances but includes also geometrical and physical considerations on everything connected with weight. Notably, it gives theorems on centres of gravity according to Ibn al-Haitham and Al-Kuhī; it mentions an instrument for measuring liquids, after Pappus; it touches on philosophical problems and, with Thābit, seeks for the 'different causes of heaviness.'"<sup>2</sup> Al-Khazini's book, which is entitled "The Book of the Balance of Wisdom," contains an excellent description of the hydrostatic balance and gives tables of specific gravities which differ in general very little from the values accepted at the present day—that of lead, for example, is given as 11 33, which compares very well with our value of 11 35.

In spite of this attention to the science of the balance, it appears that accuracy in weighing deteriorated after the eighth century. Perhaps it is a mere coincidence, but it is worth noticing that the eighth century was the time in which Arabic chemistry reached its zenith. The balance continued to play an important part in chemical laboratories, however, and we find that Al-Jildakī, who died about 1360, makes the remarkable statement that "substances do not react except by definite weights."

An excellent picture of a medieval chemical balance, in a closed glass case, is given in the British Museum MS. of Thomas Norton's "Ordinall of Alkmy."

E. J. H.

<sup>2</sup> Baron Carra de Vaux, "Les Penseurs de l'Islam," vol. 2, p. 181.

## University and Educational Intelligence.

ABERDEEN.—Prof. R. W. Reid has intimated his resignation from the chair of anatomy, which he has held since 1889.

BRISTOL.—On Tuesday, June 9, their Majesties the King and Queen visited Bristol, where they opened the new buildings of the University, as recorded in our issue of June 13, p. 913. Before proceeding to the University, the King received an address from the civic authorities, and in his reply, referring to the great generosity to the University shown by the Wills family, said that it "is a convincing proof that the race of pious founders and benefactors did not become extinct with the passing of the Middle Ages." At the University, the Chancellor, Lord Haldane, presented an address in which he pointed out clearly

the significance of the university in modern life. "It is our happy lot and duty," he said, "to cultivate and encourage learning both by imparting knowledge to those who seek it, and not less by providing facilities for its development through maturer study and research. . . . We are conscious, too, that it is incumbent upon us to bring science to the aid of industry." In his reply, the King enlarged upon this theme. The duties of the universities are: "To hold in trust for the common use the treasures of past thought, to provide for the creative minds of the present a congenial and stimulating home, to give to all the opportunity of a liberal education in the arts and sciences. . . . Their responsibilities are heavy, as their opportunities are great; and they can only rise to the full measure of their task if they be strong in public sympathy and support."

Honorary degrees were conferred on June 10 upon a few distinguished representatives of the Church, arts, and science who are natives of Bristol, or have been associated with the city or the neighbouring districts through education or public service. Among these were Lord Bledisloe, Sir Richard Gregory, and Sir J. Herbert Parsons, each of whom received the degree of D.Sc.

CAMBRIDGE.—Dr. A. B. Appleton, Downing College; Mr. D. G. Reid, Trinity College; Mr. A. Hopkinson, Emmanuel College; and Mr. V. C. Pennell, Pembroke College, have been reappointed as demonstrators of anatomy.

The Council of the Royal Agricultural Society has notified the University that it is prepared to grant the interest on the money given to the Society in 1896 by the late Sir Walter Gilbey to the University of Cambridge to assist the University to maintain the Gilbey lectureship in the history and economics of agriculture.

LEEDS.—Dr. W. H. Maxwell Telling, who has occupied the chair of therapeutics for the past two years, has been elected University professor of medicine and head of the Department of Medicine, as from October 1, on the retirement of Dr. T. Wardrop Griffith.

LONDON.—The Johnston-Lavis Geophysical Collection, which was bequeathed to the University of London by the late Dr. Henry James Johnston-Lavis, will be formally opened at University College on Thursday, June 25, at 4 P.M. After the opening ceremony has been performed by Sir Henry A. Miers, Vice-Chancellor of the University of Manchester, in the main college buildings, visitors will have an opportunity of inspecting the Collection in its temporary quarters at 134 Gower Street. Those who would care to attend are requested to communicate with the Secretary of the College.

THE Liddle triennial prize, value 120*l.*, of the London Hospital Medical College is being offered for an essay on "The etiology and treatment of primary high blood pressure." Competing papers should be sent by at latest January 30 next to the dean of the college, Turner Street, E.1.

APPLICATIONS are invited for the Gull studentship in pathology and allied subjects, including bacteriology, at Guy's Hospital Medical School. The studentship is open to candidates who have studied at the medical school of Guy's Hospital. It is of the annual value of 250*l.* and is tenable for three years. The latest date for the receipt of applications, which should be sent to the Secretary of the Board of Electors, at the School, is July 4.

## Early Science at Oxford.

June 22, 1686. The Minutes of the Dublin Society from Apr. 26, to May 17th were read: Also a discourse of Mr. Caswells, Shewing how the *Shadow* may goe back on an Horizontal plane in any latitude, if the stile point betwixt the Tropics, also on any other plane unlesse the situation thereof keeps the Sun from shining long enough thereon; together with the calculation of the time and quantity of the shadow's regression, according to the various situations, of the stile and plane.

Mr. Lloyd having observed that many curious Travellers when they visit the Repository, doe occasionally relate some remarques of their own experience, concerning things of *Nature* and *Antiquity*; he thought it might prove of some consequence to provide a Book that should lye in the Repository; wherein he might briefly set down, the contents of such relations; desireing each Gentleman to subscribe to what he communicated.

'Twas ordered that such relations should be transcribed into the Minute Book in ye method indicated by two examples written out in full by Mr. Lloyd.

June 23, 1685. Dr Plot presented severall Birds, as ye Puffin, Razor Bill, and ye Eligug, together with ye Egges of each Species; the Egges were observed to be large, but especially those of ye Puffin.

He communicated an account of incombustible cloth, drawn up by way of letter to Mr. Bayly, Fellow of ye Royal Society, and Mr. Wait, both Merchants of London; this discourse was read.

June 24, 1684. A Letter from Mr. Aston, dated June ye 21st 1684 was read; which mentioning an experiment lately made before ye Royall Society, for finding ye quantity of air, contained in Iron; it was ordered, that Mr. Aston be desired to communicate ye manner, and method, of that Experiment. In this letter were contain'd ye Minutes of ye Dublin Society, from Aprill ye 28th to June ye 2d., which mentioning that a Dog, having about 2 inches in depth, and 3 or 4, in bredth, cut off from one of ye lobes of his lungs, recovered it without any injury to him, Mr. Musgrave assured ye Society, that ye same Experiment was tried by Dr. Lower, here in Oxon, many years since, with ye same success, as he heard from Mr. Fry, formerly a Chyrurgion in this Town, who assisted ye Doctor in that Experiment.

These Minutes giving also an account that one of ye externall jugulars of a Dog, was tied without injuring ye Dog Mr. Musgrave read a paper, acquainting ye Society with what he did in this kind ye last March: the paper is as follows Sometime in March last, I tied ye 2 externall jugulars of a dog, and cut off ye veins, on this side of ye Ligatures, towards ye heart: The same experiment was tried many years since, by ye famous Dr Lower (see his book *de corde*, pag: 112, ed Amstel: 1671)

These were ye strange effects of ye Doctor's experiment, and my success, in repeating it, was also somewhat surprising, but on a different account; for I could never find, that ye dog, on which I tryed this experiment, was any way concerned, otherwise than at ye wound; I found no alteration in him at all, that I could impute to ye stoppage of ye circulation, in ye veins before mentioned &c.

About 3 weeks after this experiment, ye wounds being now heald, I tried another Experiment on ye same dog, under which he died: I examin'd him as to ye jugulars, which I found almost dried up:

This experiment was tried in ye presence of Mr. Paige, and some others, of New College.

Ordered, ye Eclipse of ye Sun on 2 July next, to be strictly observed.

## Societies and Academies.

LONDON.

Royal Society, June 11.—R. Magnus: Animal posture (Croonian Lecture). Postural centres in brain-stem compound the body musculature to combined action. Postural stimuli arise from many different sense organs. Change in position of one part of the body is followed by postural (usually harmonious) changes in other parts. Postures are adapted to environment by combined action of distance receptors and attitudinal reflexes. The righting function, absent in decerebrate, is present in midbrain animals. Righting reflexes evoked from labyrinths, exteroceptors, and proprioceptors, bring head and body into normal position. Optical righting reflexes are present in higher mammals only. Paralysis of one righting apparatus is usually compensated by other righting reflexes. Centres for righting are arranged subcortically. The resting position of the eyes changes with different positions of head, and is controlled by postural reflexes. In animals with lateral eyes (rabbits) the visual world remains fixed in spite of head movements. This is accomplished by the combined action of otolithic and neck reflexes. Motor reflexes from the semicircular canals initiate these static reactions of the eyes. Centres for all these reflexes are arranged in three groups. The red nucleus is the centre for two of the righting reflexes. Labyrinthine reactions have greater importance in lower mammals. Postural function of other parts of brain is largely unknown.

Royal Anthropological Institute, May 5.—V. Gordon-Childe: The lake dwellings in Europe in the light of the new excavations. Prior to 1920 our conception of the development of civilisation among the inhabitants of the pile villages of the Alps was perforce based on a *a priori* typological analysis of the heterogeneous material dredged up haphazard. These conceptions were largely erroneous. On Lake Neuchâtel, Dr. Vouga has found at several sites no less than four superimposed settlements. The oldest villagers used jadeite more freely and made much finer pottery than their successors. They possessed all the domestic animals and depended less on food-gathering than the later settlers, on the other hand, they may have been cannibals. In Wurtemberg the studies of Runerth of Tubingen have rendered possible the reconstruction of several types of neolithic houses and revealed pottery some of which is related to both the earliest fabrics of Lake Neuchâtel and those in use in the Danube Valley in the second neolithic period there. Beside the well-known Bronze Age village on Laibach Moor, an earlier settlement has been identified which, despite a "neolithic" inventory, probably belonged to the dawn of the age of metal as whetstones were found. On Lake Alvastra in Sweden a pile dwelling of the stone age was excavated in 1911. Its occupants had practised agriculture and possessed artefacts similar to those of the megalith builders on the coasts, but their pottery and celts were of types proper to the food-gathering population of the "dwellings-places." The "neolithic" elements from the Scandes and Swiss lake dwellings are fundamentally different. It is therefore impossible to attribute both the pile-dwelling habit and the neolithic civilisation to the "brachycephalic invaders" assumed by classical theory. Incidentally the more easterly and southerly lake-dwellings at Laibach and in Bosnia are later than the western and northern. On the other hand, a race of hunters and fishers had inhabited rafts in the early neolithic (dolmen) period in Scandinavia and even earlier in the mesolithic period in Denmark and

Yorkshire. At the same time much of the industry revealed in lake dwellings south of the Alps and Scandinavia may be derived from the mesolithic—horn harpoons and sleeves, wooden boomerangs, phalange whistles, etc. It is therefore suggested that the lake dwellers are descendants of the mesolithic food-gatherers, that the lake dwellings are improvements on the mesolithic raft—an intermediate phase being illustrated by the platform structures of Denmark and West Switzerland—but that the neolithic arts were borrowed from more advanced peoples; the Danubians in the Alps, the megalith builders in Scandinavia.

**Geological Society, May 6.**—E. B. Bailey: The Tertiary igneous geology of the Island of Mull. In Judd's region of central pneumatolysis (propylitisation), within an area measuring 15 miles in diameter, it is impossible to find a lava that has retained its olivine undecomposed. Referring to Judd's conception of central subsidence, it now appears, from the disposition of lava-types and other considerations, that central subsidence culminates in two adjacent calderas. The occurrence of many pillow-lavas within one of these calderas—at the centre of a manifestly terrestrial volcano—points to the frequent presence of a crater-lake. The crater-hollow must have been renewed by intermittent subsidence. Ring-dykes are numerous. There is conspicuous folding attributable to the lateral expansion of an early ring-dyke. Similar folding does not recur in connexion with later ring-dykes. Several ring-dykes in Mull show gravitational differentiation, which took place during crystallisation.

**Physical Society, May 8.**—E. Hughes: A magnetic bridge for testing straight specimens and an analysis of the hysteresis loop of cobalt-chrome steel. The author employs a permeameter resembling that of Iliovici, in which the currents in two coils providing the M.M.F. of a magnetic circuit containing the specimen are adjusted until no magnetic potential difference exists between a selected pair of fixed points on the specimen. In the present apparatus the required absence of magnetic potential difference is tested by bringing up a yoke until its ends abut upon the two points in question: the approach of the yoke should excite no current in a search coil wound on the specimen and connected in a low-resistance galvanometer circuit. Resistance is then added to the galvanometer, and the deflexion caused by a reversal of the two magnetising currents enables the permeability to be calculated. To form a permanent magnet the energy of which per c.c. is within 5 per cent. of the maximum obtainable, a magnetising force of upwards of 1000 C.G.S. units must be applied.—M. C. Johnson: The experimental control of electrically broadened spectral lines. Concentration of ions is the obvious controlling factor if the Stark hypothesis be adopted; recombination of ions on this hypothesis may explain the capacity and inductance curves obtained in these experiments, between 0.3 and 1.0 Å.U. This view is further tested by controlling the broadening without altering the current in the tube or the period of the discharge. The several effects involved are accounted for on the theory that line width depends on the number of charges which surround an emitting particle.—K. Rangadhama Rao: The spectra of the metals of the aluminium sub-group. Continuing the previous work on absorption of light by thallium vapour, the author has now studied the absorption of thallium vapour from  $\lambda 2400$  to  $\lambda 2000$ , and that of indium from  $\lambda 6000$  to  $\lambda 2000$ . The absorption tube was of steel, and provided with quartz windows at the ends, and absorption was

studied with a quartz spectrograph. The absorption spectra indicate marked similarities. None of the lines of the principal series appeared in absorption, even at the highest temperatures used. One remarkable feature is the very marked absorption of the members of  $1\pi_2-m\delta'$ .

CAMBRIDGE.

**Philosophical Society, May 4.**—R. H. Fowler: A theoretical study of the stopping power of hydrogen atoms for  $\alpha$ -particles. The problem of the stopping power of light atoms for  $\alpha$ -particles has been reopened by Bohr, in a way which will allow of the retention of a purely mechanical calculation of the effect on the  $\alpha$ -particle in spite of the quantum restrictions on the reactions on the atoms. This mechanical calculation of the energy lost by the  $\alpha$ -particle is carried out, taking into account the actual orbits of the electrons, instead of assuming elastically bound electrons. Circular orbits in a Coulomb field are dealt with by the method of perturbations. These must be carried to the second order for the energy, as the mean value of the first order transfer of energy is zero. The result is the same in form as Bohr's former result, but gives a slightly greater numerical value to the stopping power, which is about 10 per cent. larger as here calculated than the measured stopping powers for He and H<sub>2</sub>.—K. G. Emeléus: The action of the electrical counter. With the point positive an effect can be expected proportional to the initial ionisation due to the particle being recorded, whilst when it is negative a much larger discharge should be obtained which is almost independent of the initial ionisation. Extinction of the discharge at atmospheric pressure is brought about by a local increase of pressure near the tip of the point, probably accompanied by an electric wind along the side of the needle.—F. H. Constable: An apparatus for the investigation of the effect of poisonous substances, and mixed vapours on catalytic activity. Vapour mixtures of known composition can be supplied at a constant rate to the catalyst, which is maintained at a definite temperature. The general theory of "Centres of Activity" has been applied to selective poisoning. The decay of the reaction velocity occurs according to a logarithmic law, and the temperature coefficient is unchanged by moderate poisoning in cases in which a small fraction of the surface is catalytically active. Neither poisoning nor sintering alters the temperature coefficient of a chemical reaction, and the activity of a poisoned catalyst falls in accord with a simple logarithmic law.—R. A. Fisher: Theory of statistical estimation.—W. Burnside: (1) On the idea of frequency. (2) On the representation of the modular group of order  $\frac{1}{2}p(p^2-1)$  as a group of linear substitutions on  $\frac{1}{2}(p-1)$  symbols, when  $p$  is a prime of the form  $4n+3$ .—J. P. Gabbatt: On pedal quadrics in non-euclidean hyperspace.—F. P. White: An extension of Wallace's, Miquel's, and Clifford's theorems on circles.—H. F. Baker: (1) The stability of rotating masses of liquid. (2) Note on a formula for Lamé functions.—M. J. M. Hill: (1) On the substitution of Wallis's postulate of similarity for Euclid's postulate of parallels. (2) On the hypothesis of the obtuse angle.—J. D. Cockcroft: The temperature distribution in a transformer in which heat is generated at a uniform rate. The continued increase in the size of transformers has made a more exact knowledge of the temperature distribution in the laminated cores necessary. The temperature distribution in an infinite rectangular laminated core is found and the solution applied to an oil-cooled transformer core.—C. G. F. James: Some formulæ for scrolls and line systems in higher space.

## DUBLIN.

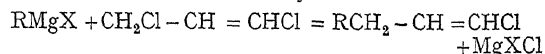
Royal Dublin Society, May 26.—Report of the Irish Radium Committee for the year 1924. The report shows that 12,885 millicuries of emanation were issued for therapeutic purposes during the year. A temporary laboratory has been fitted up at Ballsbridge for carrying on the work of the Radium Institute. Reports from some of the largest medical users of emanation in Ireland are included. These contain numerous records of successful results obtained with radium treatment.—F. E. Hackett: The Zeleny electroscope and its uses as a lecture demonstration instrument.

## PARIS.

Academy of Sciences, May 18.—F. E. Fournier: General properties of the simple satellite wave produced by the translation of hulls of forms favourable to high speeds.—Maurice Hamy: Cutting optical surfaces with elliptical or hyperbolic sections.—H. Deslandres: Complementary researches on the structure and distribution of band spectra. New measurements of absorption bands in the infra-red of oxygen, carbon monoxide, hydrocyanic acid, ammonia, water vapour and methane. For these six gases the absorption bands may be represented

by the formula  $K = q \frac{1062.5}{r.s}$ , where  $q$  is an integer,  $r$  is an integer, and  $s$  a third integer equal to the number of atoms in the molecule.—Marin Molliard: The action of high temperatures, compatible with life, on the development of cells: Studies in the mode of development of *Stenogastrocystis nigra* at temperatures ranging between 36° C. and 44° C.—L. Lindet: The coagulation of casein in the presence of calcium salts in acid solution.—C. Sauvageau: The culture of the alga *Streptothalia Liagorae*.—V. Romanowsky: The generalisation of an inequality of A. Markoff.—J. Le Roux: The variation of mass.—Raymond Chevallier: Ferromagnetic ferric oxide. Starting with a commercial finely powdered black oxide of iron, this is oxidised by air at a temperature of 350° C. It then has the composition of ordinary ferric oxide but is of a yellowish colour and is strongly magnetic. This ferromagnetism is lost on raising the temperature to about 700° C.—Marcel Peschard: The magnetisation of the ferro-nickels: thermomagnetic properties.—S. Pina de Rubies: New lanthanum lines in the arc spectrum at normal pressure between 3100 I.Å. and 2200 I.Å.—Jean Lecomte: The infra-red absorption spectrum of aldehydes and ketones. The absorption spectra of the fatty aldehydes and their isomeric ketones are not identical, and the characteristic band of the carbonyl group is not the same in the fatty and aromatic series. For a thickness of a small fraction of a millimetre, aldehydes and ketones give absorption spectra showing well-defined strong bands capable of being utilised for analytical purposes.—R. de Malleman: The electrical double refraction of limonene. Kerr's constant for limonene is intermediate between that of benzene and that of toluene; it is nearly four times that of pinene, a difference attributed by the author to the presence in the molecule of a double bond external to the ring.—L. de Broglie and Jean Jacques Trillat: The physical interpretation of the X-ray spectra of the fatty acids.—Mlle. Irène Curie and Nobuo Yamada: The particles of long range emitted by polonium. The lack of homogeneity in the metallic screens employed in previous work was found to give rise to difficulties, and these screens have been replaced by a layer of compressed gas (dried air, oxygen, or carbon dioxide). It was proved that the arresting power of these gases was proportional to the pressure. In spite of the precautions taken in the preparation and preservation

of the specimens, there always remained a small number of particles with a long range, and this number is nearly proportional to the quantity of polonium, but does not depend on the nature of the metal on which the polonium is deposited. These particles do not form a homogeneous group.—Georges Fournier: The absorption of  $\beta$  rays by matter.—Pierre Chevenard and Albert Portevin: Results obtained by the dilatometric study of cast irons. The dilatometric study of cast iron enables the complex transformations produced during heating or cooling to be followed, and appears to possess advantages over the thermal method for phenomena occurring in the solid state.—Xavier Waché and Georges Chaudron: The influence of thermal and mechanical treatment on the velocity of solution in hydrochloric acid.—E. Demoussy: The displacement of acids by diffusion. The consideration of the relative mobilities of the ions of a mixture of salt plus acid, together with a knowledge of the degree of ionisation of the acid, suffices to predict the direction of the partition of the diffusion products.—H. Pelabon: The direct formation of the mercury oxybromides.—Mlle. S. Leduc: The action of *p*-anisyl magnesium bromide and *p*-tolyl magnesium bromide on camphor.—L. Bert: A general synthetic method for the preparation of  $\omega$ -chloroallyl cyclic derivatives, and through these, acetylenic hydrocarbons, alcohols, and aldehydes. The reaction



has been realised experimentally when R is C<sub>6</sub>H<sub>5</sub>. The reaction has been proved to be general for other aryl groups.—Georges Brus: The action of chlorine on  $\alpha$ -pinene. Starting with pure pinene, free from nopinene, the author has obtained bornyl chloride, liquid dichlorides, a crystalline dichloride differing from products previously obtained in this reaction, together with small quantities of higher chlorine derivatives.—R. Lantz: The aryliminonaphthoquinones. The action of aromatic amines.—L. Cayeux: The submarine origin of the silex nodules and beds of chalk of the Paris basin.—Frédéric Hermann: The bundle of reversed folds of Valsavarenche and the prolongations of the Bagnes fan in the Franco-Italian Alps.—A. Demolon: The chemical constitution of brick earth.—Aug. Chevallier: The Leguminosae (Tephrosia) cultivated in tropical countries for capturing fish: their use and geographical distribution.—St. Jonesco: The action of mineral and organic acids combined with that of metallic sodium on the reddening of some flavones.—P. Lasareff: The sensation of the intensity of sounds according to the ionic theory of stimulation.—R. Legendre: The principle of a method for estimating the variations of dissolved carbonic acid.—A. H. Roffo: Cholesterol and haemolysis.—W. Kopaczewski: Electrocapillary analysis of colloidal colouring matters.—Ch. Porcher: The various complexes, caseinate of lime + phosphate of lime, and their mode of behaviour towards rennet.—G. Guittoneau: The rôle of rennet and its mode of action in the manufacture of Gruyère and Emmenthal cheeses.—Lemoigne: The origin of the  $\beta$ -oxybutyric acid obtained by the action of microorganisms. The non-autolysed *M. bacillus* contains an amorphous product, which can be isolated by chloroform and after saponification gives  $\alpha$ -crotonic acid. The latter product may be considered as the mother substance of the  $\beta$ -oxybutyric acid.—Clément Simon, Ch. Flandin, Seguin and Lecoq: The action, *in vitro*, of pancreatic extracts on the Nagana trypanosome and *Spirochaeta Gallinarum*.—Robineau and G. Contremoulins: The reactions on the human organism of prothetic or synthetic bone sterilised by boiling alcohol.

## Official Publications Received.

- Department of the Interior: United States Geological Survey. Water Supply Paper 531: Surface Water Supply of the United States, 1922. Part I: North Atlantic Slope Drainage Basins. Pp. vi+258+2 plates. (Washington: Government Printing Office) 25 cents.
- Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 76, 1924. Pp. iii+444+21 plates. (Philadelphia.) 6.25 dollars.
- Smithsonian Miscellaneous Collections. Vol. 77, No. 2: Explorations and Field-Work of the Smithsonian Institution in 1924. (Publication 2794) Pp. iii+136. (Washington: Smithsonian Institution.)
- Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 243: Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory near Tucson, Ariz., 1921 and 1922. By Daniel L. Hazard. Pp. 99+5 plates. Serial No. 292: Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory at Vieques, P.R., in 1921 and 1922. By Daniel L. Hazard. Pp. 98+4 plates. (Washington: Government Printing Office.) 15 cents each.
- Experimental Vegetation: the Relation of Climaxes to Climates. By T. C. Whitcomb and John E. Weaver. (Publication No. 355.) Pp. vi+172+15 plates. (Washington: Carnegie Institution.)
- The Phytometer Method in Ecology: the Plant and Community as Instruments. By Frederic E. Clements and Glenn W. Goldsmith. (Publication No. 356.) Pp. vi+106+11 plates. (Washington: Carnegie Institution.)
- Papers from the Department of Marine Biology of the Carnegie Institution of Washington. Vol. 1: A Memorial to Alfred Goldsborough Mayor. Part I: Papers of A. G. Mayor, relating to his Work at Tutuila Island and adjacent Regions; together with Reports of R. A. Daly, R. T. Chamberlin and C. B. Lipman on their Work in the same Connection. (Publication No. 340.) Pp. viii+217+56 plates. (Washington: Carnegie Institution.)
- Cenozoic Vegetation of Western North America with Special Reference to the Pliocene, Miocene, and Pliocene. By R. A. Daly. Pp. xiii+208+48 plates. (Washington: Carnegie Institution.)
- Contributions to Embryology. Vol. 16, Nos. 78-84. (Publication No. 361.) Pp. 276+32 plates. (Washington: Carnegie Institution.)
- City of Norwich. The Report of the Council Committee to the Council. 1924. Pp. 25. (Norwich.)
- Transactions of the Astronomical Observatory of Yale University. Vol. 8, Part 3: Theory of the Trojan Group of Asteroids. Conclusion of Chapter I, and Chapters II to VI: Development of the Theory and Applications. By Prof. Ernest W. Brown. Pp. 81-133. (New Haven.)
- United States Department of Agriculture. Department Bulletin No. 1824: The Forest of India. By Charles H. Richardson. Pp. 18. (Washington: Government Printing Office.) 5 cents.
- Forest of India. By C. Claude Wilson. Pp. ii+7+4 plates. (Calcutta: Government of India Central Publication Branch.) 7 annas, 9d.
- Union of South Africa. Department of Mines and Industries: Geological Survey. Memoir No. 19: The Coal Resources of Union of South Africa. Vol. 2: The Inland Coalfields of Natal. By W. J. Wybergh. Pp. 180+6 plates. (Pretoria: Government Printing and Stationery Office.) 10s.
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- Chemistry Series, Vol. 11, Part 6: Notes on the Chemistry of Essential Oils. Part 17. By Madyar Gopal Rau and John Lionel Simonsen. Pp. 8. 2 annas; 3d. (Calcutta: Government of India Central Publication Branch.)
- Notes on the Protection of Birds. The 1924 Annual Report of the British Ornithologists' Union. December 31st, 1924. Pp. 1. (London: 82 Victoria Street, S.W.1.) 1s.
- Proceedings of the South London Entomological and Natural History Society, 1924-25. Pp. xix+142+8 plates. (London: Librarian Chambers, London Bridge, S.E.1.) 12s. 6d.
- Field Museum of Natural History. Zoological Series, Vol. 12, No. 8: Two new Birds from Peru. Reports on Results of the Captain Marshall Field Expeditions. By John T. Zimmer. (Publication 228) Pp. 101-109. (Chicago.)
- The Journal of the Royal Agricultural Society of England. Vol. 85, 1924. Pp. 12+447+11 plates. (London: John Murray.) 15s.
- Report of the Astronomer Royal to the Board of the Royal Observatory, Greenwich. Read at the Annual Visitation of the Royal Observatory, 1925, June 6. Pp. 21. (Greenwich.)
- Koninklijk Nederlandsch Meteorologisch Instituut. No. 108: Seismische Registreringen in De Bilt, 10, 1922. Pp. xvi+47. (Utrecht: Kemink & Zoon.) 1.20 fl.
- Report of the Marlborough College Natural History Society for the Year ending Christmas, 1924. (No. 78) Pp. 146. (Marlborough.) 8s. 6d.
- Aeronautical Research Committee. Reports and Memoranda. No. 933 (Ae. 154): Forces and Moments on a Model due to Controls on a Model Fairey "N4" Flying Boat *Atalanta* at various Angles of Yaw. By H. B. Irving and A. S. Batson. (A.2.a. Stability Calculations and Model Experiments, 87-T 1974.) Pp. 14+12 plates. 1s. net. No. 941 (M.N. 8): Measurement of Vertical Currents in the Lowest Layers of the Atmosphere during Sea-Breezes. By J. Durward. (A.5. Meteorology, 100-T. 1887.) Pp. 5+3 plates. 1s. net. No. 952 (Ae. 171): The Effect of the Angle of Incidence on the Lift and Drag of two Aerofoils measured over 360° Range of Incidence. By C. N. H. Lock and H. C. H. Townsend. Pp. 5+4 plates. 6d. net. (London: H.M. Stationery Office.)

- Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 505: Critical Potentials associated with Excitation of Alkali Vapor Spectra. By F. L. Mohler. Pp. 165-191. (Washington: Government Printing Office.) 10 cents.
- Koninklijk Meteorologisch Instituut. Observatorium te Batavia. Jaarverslag 1922. Pp. 1. (Batavia: Landsdrukkerij.)
- Southern Rhodesia. Report of the Director Geological Survey, for the Year 1924. Pp. 11. (Salisbury.)
- British Empire Exhibition, 1925. Official Guide. Edited by G. C. Lawrence. Pp. 128. (London: Fleetway Press, Ltd.) 1s.
- Egyptian Government Almanac for the Year 1925. Pp. viii+800. (Cairo: Government Publications Office) 5 P.T.
- Verhandlungen der Schweizerischen Naturforschenden Gesellschaft. 105. Sitzung, 4. Oktober 1924 in Luzern. 1 Teil. (Académie des Sciences naturelles. 105e session ann. 1924. 4. Octobre 1924 à Lucerne. 1re partie.) Pp. 252+60. (Aarau: H. R. Sauerländer & Cie.)

## Diary of Societies.

SATURDAY, JUNE 20.

- ASSOCIATION OF WOMEN SCIENCE TEACHERS (Summer Meeting) (at Birmingham University), at 10.45.—Business Meeting.—At 11.30.—Dr. Shakespear: Colour (Lecture)
- ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section) (in Bio-chemical Laboratory, Cambridge), at 2.30.—Dr. Ray and Dr. Vines: Bone Formation and Experimental Rickets.—At 4.45.—Dr. J. F. Gaskell: The Relationship of Experimental Pneumonia in Rabbits to the Pneumonia of Childhood

MONDAY, JUNE 22.

- INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Summer Meeting) (at Queen's Hotel, Bath), at 9.30 A.M. (Also on June 23 and 24.)
- ROYAL IRISH ACADEMY, at 4.10.
- ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Prof. J. C. McLennan, Lord Rayleigh. The Aurora and its Spectrum. Chairman: Sir Ernest Rutherford.
- ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presentation of the Royal Gold Medal.

TUESDAY, JUNE 23.

- ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.
- ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Lt.-Col. J. Cunningham: Some Factors in Racial Immunity and Susceptibility to Disease.

WEDNESDAY, JUNE 24.

- ROYAL SOCIETY OF ARTS, at 4.—Annual General Meeting.
- GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. W. J. Sollas: On a Sagittate Section of the Skull of *Australopithecus africanus*.—D. Parkinson: The Faunal Succession in the Carboniferous Limestone and Bowland Shales at Clitheroe and Pendle Hill.—Janet M. M. Dineen: On *Orthotria*, a New Genus of Carboniferous Corals.
- ROYAL SOCIETY OF MEDICINE (Medical Section) (at Royal Society of Medicine), at 9.30.—Dr. I. D. Suttie: An Irrelevant Accusation to the Medical Profession.

THURSDAY, JUNE 25.

- ROYAL SOCIETY, at 4.30.—D. H. Black:  $\beta$ -Ray Spectra of Thorium Disintegration Products.—Miss C. F. Elam: Tensile Tests of Crystals of an Aluminum Zinc Alloy.—Dr. G. Shearer. On the Distribution of Intensity in the X-Ray Spectra of Certain Long-Chain Organic Compounds.—C. F. Jenkin: High Frequency Fatigue Tests.—L. W. Bryant and D. H. Williams. An Investigation of the Flow of Air around an Aerofoil of Infinite Span. With an Appendix by Prof. G. I. Taylor, Note on the Connection between the Lift of an Aerofoil in a Wind and the Circulation round it.—To be read in title only.—Prof. T. H. Havelock: Wave Resistance: the Effect of Varying Draught.—Prof. C. V. Raman and L. A. Ramdas: The Scattering of Light by Liquid Boundaries and its Relation to Surface Tension, Part III.—W. H. George: An Electrical Method for the Study of Impact applied to the Struck String.—F. H. Constable: The Mechanism of Catalytic Decomposition. S. A. Emerson and Dr. L. C. Martin: The Photometric Measurement of the Partial Osmotic Pressures and Viscosities of Solutions.—Miss Mary W. Porter: A Contribution to the Study of the Optical Properties of Mixed Crystals.—H. Gregory and C. T. Archer: Experimental Determination of the Thermal Conductivities of Gases.—D. B. Deodhar: On the Atmospheric Radio-activity and Indian Weather.—Prof. J. R. Partington and A. B. Howe: The Ratio of the Specific Heats of Hydrogen.—A. Cary and Dr. E. K. Rideal: The Behaviour of Crystals and Lenses of Fats on the Surface of Water. Part I.—G. H. Henderson: The Capture and Loss of Electrons by  $\alpha$ -Particles.—Dr. A. S. Parkes: The Effects on Fertility and the Sex-ratio of *Scaptomyza* Flies Exposed to X-rays.—R. N. Chrystal: The Germination of *Claviceps* and *Claviceps* in Britain and its Relation to the Production of Ergot.—The Effect of Low Temperatures on Hens' Eggs.—And other papers.

FRIDAY, JUNE 26.

- PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. A. Russell: The Electric Field of Two Spheres when Touching One Another.—Miss S. M. V. V. J. O. C. Vick: An Investigation of the Control Conditions under which Newton's Law is valid for the Emission of Heat from Electrically Heated Wires.—I. Jones: Condensation of Nuclei Produced by the Illumination of Air-halogen Mixtures.
- ROYAL SOCIETY OF MEDICINE (Anaesthetics Section) (at Manchester University).—Dr. H. P. Fairlie and others: Discussion on Chloroform.—S. R. Wilson and Dr. S. McSwiney: Animal Demonstration showing Effects of Adrenalin Injections during Ether and Chloroform Anaesthesia.



SATURDAY, JUNE 27, 1925.

## CONTENTS.

	PAGE
The North Sea Plaice Investigations. By Prof. J. Stanley Gardiner, F.R.S. . . . .	969
Faculty Organisation at Cambridge . . . . .	971
The Founders of American Geology and their Work By Sir A. Strahan, K.B.E., F.R.S. . . . .	972
The Brauner Jubilee Volume By Prof. F. G. Donnan, F.R.S. . . . .	975
British Butterflies. By F. A. D. . . . .	975
Our Bookshelf . . . . .	976
Letters to the Editor :	
On the generally accepted Explanation of the Zeeman Triplet on a Quantum Basis.—Prof. W. M. Hicks, F.R.S. . . . .	978
On the reported $K\beta_4$ Line in the X-ray Spectra of Molybdenum and Palladium.—Dr. Samuel K. Allison . . . . .	978
A Substitute for a Liquid Air Trap for Mercury Vapour in Vacuum Systems.—Prof. A. Li. Hughes and F. E. Poindexter . . . . .	979
The Oogenesis of Lumbricus.—Prof. J. Bronté Gatenby . . . . .	979
Band Spectra of Lead Isotopes.—Dr. Etienne S. Bieler . . . . .	980
Petroleum in Uganda. — E. J. Wayland; The Writer of the Note . . . . .	980
Paramagnetism and the Electronic Configuration of the Atom.—Dr. L. C. Jackson . . . . .	981
A Luminous Spider.—Barnum Brown . . . . .	981
The Relations between Sunspots, Terrestrial Magnetism, and Atmospheric Electricity. By Dr. C. Chree, F.R.S. . . . .	982
An International Campaign against Sleeping Sickness. By E. E. A. . . . .	985
Current Topics and Events . . . . .	986
Research Items . . . . .	991
The South-Eastern Union of Scientific Societies. ANNUAL CONGRESS AT FOLKESTONE . . . . .	995
The Calculation of World Temperatures. By R. S. R. . . . .	995
Botanical Exploration in China. By O. S. . . . .	996
University and Educational Intelligence . . . . .	997
Early Science at Oxford . . . . .	998
Societies and Academies . . . . .	998
Official Publications Received . . . . .	1000
Diary of Societies . . . . .	1000
The Centenary of the Discovery of Benzene. — Michael Faraday . . . . .	1001
Faraday as a Chemist. By Sir William J. Pope, K.B.E., F.R.S. . . . .	1002
The Faraday Benzene Centenary. By Prof. Henry E. Armstrong, F.R.S. . . . .	1010
Faraday and his Contemporaries. By Prof. Ernst Cohen . . . . .	1014
The Royal Institution: NEW HONORARY MEMBERS . . . . .	1016

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The North Sea Plaice Investigations.<sup>1</sup>

IT is unnecessary to point out that the plaice occupies a unique position in the eyes of the public and hence of the fishing industry in general. Its southern limit of range is the English Channel, its depth range about seventy fathoms, and its ground sand or sandy mud; its preference is for a temperature of 60°-70° F. It necessarily follows that its chief area is the North Sea, a ground peculiarly important on account of its proximity to centres of population. The annual figures of catch for this area showed a falling catch up to 1914 with an increase of fishing, and the problem set to the scientific staff of the Ministry of Agriculture and Fisheries was to ascertain the facts of this fall in conjunction with the food, breeding habits, and rate of growth of the plaice, and with its environment (nature of the bottom, temperature, salinity, etc.), and, if the fall should be established, to suggest remedies. The report before us sums up the whole position, giving the facts and critically considering the possibility of remedies. There is really nothing more to be said, only to consider whether any attempt is to be made to improve the position or not.

Remedies would necessarily entail some degree of interference with the utilisation of the chief plaice grounds of the area, the southern part of the North Sea, in which the English Ministry is particularly interested, in a manner which is comparable to "stock farming," in which the endeavour is to market the maximum amount of meat per unit area, while, by breeding, keeping up the stock to the maximum number that the land will carry. Here there can be at present no artificial growing of fish food, dependence having to be on the natural supply of animal and free-moving life, which, of course, must fluctuate with fluctuating physical conditions. Then, whereas there are only cattle, sheep, and pigs on a farm, here there are a dozen kinds of fish, more or less in feeding competition with each other, the relative values of which in cash and as food must be determined. The annual production of eggs by each fish varies to hundreds of thousands, of which from each fish only a pair must develop to maturity to maintain the stock. Does it pay to increase the number of spawning fish so as to get a still larger number of eggs, or would it be better to kill off a large percentage of fish before they reach maturity? Obviously, as there would be waste of substance in unproductive spawning, this entailing the utilisation of fish food to no farming advantage, a reply must be sought in the question as to what extent plaice may be profitably marketed before maturity.

<sup>1</sup> Ministry of Agriculture and Fisheries. Fishery Investigations Series II Vol. 7, No. 6, 1924. Report on the English Plaice in the North Sea during the Years 1921-1923. By J. (Stanley) Gardiner. H. M. Stationery Office, 1925. 138 net. Thursby-Pelham. Pp 96 (London: H. M. Stationery Office, 1925.) 138 net.

Fortunately, to most of these questions science has given answers, as previous reports have shown, but it remained to determine the results of that most gigantic experiment, the closure of the North Sea to fishing vessels during the War, a closure almost complete in the English area. It is shown in the present report that in 1913, 1920, and 1923 there were 24, 33, and 22 thousands of tons of plaice landed from English vessels. These figures point to the conclusion of the experiment, but, lest the fall to pre-War conditions should be deemed to be due to less fishing in 1923, the catch per 100 hours' fishing and per day's absence from port of first-class fishing vessels is computed, the weights of plaice per day caught by a steam trawler in the three years mentioned being 2.1, 3.4, and 1.9 cwt. The whole North Sea is divided up into areas, 1° long. by 0.5° lat., and the figures are worked out for each rectangle in the years 1920 to 1923, and shown in a long series of charts. The analysis goes, however, much further, and the plaice caught are divided into large (above 45 cm.), medium (roughly 34 to 44 cm.), and small (less than 34 cm.), and the numbers of cwt. of each caught per 100 hours' fishing are shown. The breaking up of the area into rectangles does not agree with depths—these are shown by contour lines beneath—nature of the bottom, temperature, currents, etc., but the charts give at a glance an accurate estimate of the adult and semi-adult plaice population of the North Sea, the quality of value for human consumption.

Taking the whole area, a steam trawler in 100 hours' fishing caught in 1920 approximately 7 cwt. large plaice, 8 cwt. medium, and 3 cwt. small, the corresponding figures in 1923 being 2, 4, and 7. We should estimate the food and cash values of the catch in the former year as at least two and a half times greater than in the latter, and the result is an appallingly lessened production of human food and no living wage for the actual plaice fishermen. Foreseeing that any remedy proposed would entail interference with a whole industry, the fullest consideration is given to every figure in a section of the Report entitled "Size Composition of the North Sea Plaice Stock," extraordinary in the knowledge summarised and masterly and concise in treatment. It, in particular, gives the analyses of the results obtained by a number of sea-going fish measurers, who, sailing in commercial vessels, measured upwards of 1,200,000 plaice in the five years from 1919 to 1924; it annihilates any question of differences between "laboratory" and commercial conditions. Lastly, the relation of growth to age in the post-War period is determined, and a full consideration is given to a new post-War method of fishing by the use of seines on the high seas.

Science, having proved beyond a doubt the serious

depletion of the plaice in the North Sea by the operations of man, after having made the fullest allowances for natural seasonal fluctuations, now sets out to suggest practical measures. The most attractive of these is transplantation from overstocked to understocked areas, from coastal grounds to such isolated shoals as the Dogger Bank, which has a peculiarly high capacity for supporting plaice. In this connexion the experiments of Mr. Borley, 1904-8, are now classical. We have, too, the work of Petersen, an annual profit of 100,000 kr. since 1908 against an annual expenditure of 5000 kr., figures for transplantation in certain Danish territorial waters and not for the high seas, open to every nationality. A limit of length, below which no fish could be marketed, would seem to be simpler, but it would have to be considerably higher than 22 cm.—the size proposed before the War by the International Council (this is about the size now considered unprofitable by English trawlers), and indeed higher than 25 cm., which was considered desirable by the Council but not proposed as a practical measure; for neither of these limits would prevent steam trawlers and seiners from visiting the small plaice grounds and killing vast numbers of tiny plaice while in search of other fish. A third remedy, an increase in the size of the net's mesh, is not practicable, for the trawl has to catch round as well as flat fishes.

There remains the formation of reserves, where young fish would grow to marketable size and whence they would spread over the whole North Sea, this clearly being the measure favoured by Messrs. Borley and Pelham as being most certain and effective. They clearly prefer complete closure of these reserves to all classes of fishing—any measure which is the same for all would alone appear tolerable to our fishermen—but partial closure is mentioned. The scientific evidence in our opinion is conclusive, and we regard the whole question as now in the hands of the executive to decide in the first instance whether they will try to do anything or not. If it is determined to make the attempt, Britain must either, with other countries, enforce a size limit, which will almost certainly be ineffective, or, better, endeavour by agreement to close, as a first experiment, a small area to all fishing vessels. Such a closure would undoubtedly be attempted, were there a young plaice ground to the west of the North Sea, near England. Unfortunately the only experimental closure of value would have to be on the east side, the difficulties in respect to which, however, are not insurmountable, provided the English Minister for Agriculture and Fisheries has the courage to propose it as a subject of negotiation between all the countries concerned; he will be in a strong position, for all the fishery experts of these countries are agreed as to its desirability and our

own fishermen clearly see the necessity for remedial measures.

It is certain that the continuance of the depletion of the plaice stock of the North Sea will lead to a complete disorganisation of the steam trawler industry in its southern part. The owners will either have to lay up their vessels or shift them to ports already overcrowded, while the fishermen will have either to "go on the dole" or to push in to some other part of the industry. It is proved that the danger is a real and immediate one, and, as such, it should surely be faced without delay, while remedial measures are still possible.

J. STANLEY GARDINER.

### Faculty Organisation at Cambridge.

THE University Commissioners have published for information certain draft statutes that they are considering on the question of faculty organisation in the University of Cambridge. Among many points of interest to those who may be concerned in administering the new scheme, and to those who will have to live and work under it, a few may be mentioned in a brief preliminary survey. Two schools are created for the scientific studies: the School of the Physical Sciences including the faculties of engineering, mathematics and physics, and chemistry, and the School of the Biological Sciences including the departments of anatomy, botany, genetics, geology, parasitology and zoology, which form one faculty, and the departments of biochemistry, experimental psychology, pathology and physiology, which form a second biological faculty. The remaining faculties, which are not purely literary or belonging to the fine arts, are economics and politics, moral science, agriculture, archæology and anthropology, geography and medicine.

The separate faculties consist of the regular teaching staff working in the faculty. Boards of faculties will be formed, corresponding to the present special boards of studies; the duties of the boards of faculties are to be to provide adequate instruction and facilities for research in their departments and to arrange the examinations in their subjects of study. The boards are to determine the remunerations of the members of the faculty staffs, but there is no indication in the draft statutes that they will actually have the power to handle any funds. This is a very necessary power in connexion with such matters as departmental libraries, and provision should be made for it at some point in the statutes.

The new General Board of Studies is to be a smaller body than the present one and to consist, in addition to the vice-chancellor, of four members elected by

the boards of the literary faculties acting in common, four members elected by the boards of the scientific faculties acting in common, and four members of the council elected by the council. A considerable amount of work is to fall upon the new General Board in framing and supervising the educational policy of the University. In dealing with problems affecting a particular faculty, the General Board may have a representative of the faculty board present, and in dealing with matters affecting several faculties it may get help from the council of a School, the kind of super-faculty, advocated by Sir Joseph Larmor and others, for which arrangements have been made in the scientific schools mentioned above.

Amongst clauses of interest in the proposed new statutes on the University teaching officers, we may mention the general adoption of the federated super-annuation scheme for universities and arrangements for a sabbatical year—one term's freedom from duty for every six terms during which an officer has discharged the duties of a teaching officer. The question of stipend during an absence of not more than a year is left undecided, perhaps necessarily so. Another important point is that women are to be eligible for all teaching offices in the University. Here, presumably, restrictions will have to be imposed in such cases as that of a divinity professorship carrying with it a canonry at Ely. The basic amount of teaching for University lecturers and demonstrators is also laid down, and a minimum is fixed for the basic rate of pay. The amount of teaching that a University lecturer may give on behalf of a college in the way of supervision is limited, and the permission of the General Board has to be obtained for any other teaching given in full term by the lecturer.

In the attempt to separate the recognised lecturer from the private coach, and to limit the amount of teaching that the lecturer may give, there is presumably a desire to keep the lecturer free to carry on research. With this desire general sympathy must be felt. It is obvious, however, that this part of the scheme can only work satisfactorily if the financial side is also capable of satisfactory adjustment. It will want very careful handling and very careful watching if the University is to steer clear of the danger of driving an impecunious, young, but successful teacher out of its official ranks. Close co-operation of the General Board of the faculties with the faculty boards and with the college councils will be very necessary here. The question must be largely a financial one, and full consideration of it must be deferred until the financial side of the faculty organisation has been developed and made available.

## The Founders of American Geology and their Work.

*The First One Hundred Years of American Geology.*

By George P. Merrill. Pp. xxi+773+36 plates.  
(New Haven: Yale University Press; London:  
Oxford University Press, 1924.) 27s. 6d. net.

**M**R. MERRILL has spared no trouble in collecting material for this history. The imaginings of the earliest speculators on the history of the earth, and sketches of their lives and characters, are presented almost too liberally, so far as regards the first eight chapters of the book. I trust that I shall not appear ungrateful if I say that these chapters leave me with a feeling of bewilderment. The geological paragraphs, in themselves disconnected, are mixed up with biographical matter, while the biographical information, scattered here, there, and anywhere, fails to convey a clear idea of what any one man was thinking at any one time. Obviously a strictly chronological arrangement was impossible, for episodes in the development of geology overlap indefinitely, nor did one geologist wait for the death of another before beginning to publish. Nevertheless, if the author, in developing his theme, had concentrated either on the growth of geology, or on the biographies, his work would have had less the appearance of having been made up of extracts from a notebook.

Chapters ix. to xv., on the other hand, are good examples of historical treatment. Each is devoted to the discussion of some one of the great problems which have exercised the minds of American geologists. The various stages from the initiation of the problem to the solution as accepted to-day are clearly set out, and the comparative progress made in Europe and America can be realised.

The biographical notices, nevertheless, are full of interest. Aided by numerous portraits, they enable us to realise what manner of men they were who founded American geology. One is struck at once by the diversity of professions from which the lure of the rocks drew geologists, early and late, in the United States as in Europe. Lawyers, doctors, ministers, engineers, soldiers, politicians, business men, dentists, all contributed. We are deeply impressed, too, by the immensity of the field that awaited exploration by these men. Physical features and geological agencies presented themselves with a grandeur and on a scale for which there is no room in Europe. The effect of such an environment is apparent. American geologists distinguished themselves, as we learn on p. 663, "in studies tending towards the solution of, first, the fundamental problems of continental uplift and depression as made by Dana; second, in those relating

to the physics and structure of mountain ranges, made by Rogers brothers, le Conte, and Dana; third, in those relating to glaciers and glaciation by Agassiz and the elder Hitchcock, and later by Chamberlin; fourth, in those relating to isostasy and physiography, made by Dutton, Gilbert, and Powell in the arid regions; and fifth, in those relating to vertebrate evolution, made by Leidy, Cope, and Marsh." As regards glaciation, however, it should be remembered that Agassiz laid the foundations of his theories in Switzerland, the country of his birth, though he further developed them after his transference to the United States.

The book opens with an account of the Maclurean Era, 1785-1819. Maclure, "the William Smith of America," was born in Scotland in 1763. He made a fortune in business and, after travelling extensively in the Old World, he settled in the United States. There he not only became a liberal patron of science, but also by his own personal exertions in the field, often under extreme privation, he collected sufficient material to enable him to publish the first geological map of America in 1809.

During this era, progress lay chiefly in the hands of men engaged in the so-called learned professions. Mostly self-trained and hampered by the mental attitude of the times, these men were faced by a pathless wilderness of vast extent, inhabited, if at all, by more or less hostile Indians. Observations in the field and the collecting of facts were therefore matters of extraordinary difficulty, but speculations on such phenomena as earthquakes and volcanoes, on the origin of glacial drift, on the structure of the globe and other inviting objects, were not lacking. Maclure, as regards his own views, summed up the matter: "All these speculations . . . can be accounted only as an amusement at present." Men's minds, moreover, were dominated by the belief that the Noachian deluge was a world-wide catastrophe, and that the Scriptural narration of the creation must be taken literally. Thus the bones of a mammoth found at Albany in 1705 clearly corroborated the Scriptural account of a race of antediluvian giants. One may smile at the crudeness of these early speculations, but these men had the sagacity to realise what is not realised by the majority even now, that there were things in the world around them that could be, and ought to be, explained. Yet one almost fears that the author may have been more conscientious than kind in rescuing some of the crudest theorisings from their decent oblivion.

In 1802, when Silliman was appointed professor of chemistry and natural science in Yale, no science was taught in the United States or England. He had some acquaintance with law but none whatever with science, and thus found himself in somewhat the same position

as Sedgwick when he became professor of geology at Cambridge. Yet he did more by his teaching than any other man of his day to advance the science of geology. His name is best remembered by his *American Journal of Science*, founded in 1818 and still continuing. But he made some sagacious observations, such, for example, as his terse description of East Rock, New Haven, as a rock that had been melted and ejected among the superior strata, but never erupted like lava. Its form he attributed to erosion. *Silliman's Journal* was largely concerned with geology, and he resented the rivalry of the *Monthly American Journal of Geology* founded by Featherstonehaugh. The monthly journal, though warmly blessed by Murchison, Conybeare, Sedgwick, Buckland, and Greenough, had but a short life.

The origin of basalt was still being keenly debated in 1816. The Neptunists proved its aqueous origin and the Plutonists its igneous origin, each to their own complete satisfaction. In 1816, Emmons gave up his practice as a doctor and took a post on the Geological Survey of New York. Thence arose the great Taconic controversy, a battle royal that led to the shedding of as much ink as any of our controversies in Britain. It will be noticed later on.

Chapter ii. deals with the Eatonian Era, 1820-29. Amos Eaton gave up the law in 1816, when he was forty, and attended lectures by Silliman. Thereafter he travelled thousands of miles, lecturing on natural history and rousing "uncontrollable enthusiasm." He considered "nothing in geology entitled to much confidence, which is purely theoretical," but was not deterred thereby from accounting for the elevation of the continent by a great explosion which rent the crust of the earth in a north and south direction. His great work was the "Index to the Geology of the Northern States," first published in 1818. In 1820 he brought out a second edition, in which many of his earlier opinions were re-stated in his customary emphatic manner. He was a man of forceful character, as might be judged by the portrait forming Plate V.

Scientific methods were now developing. The value of fossils for purposes of correlation, as taught by Cuvier and Brongniart, was being realised, and was tested on the Atlantic Coast Tertiary deposits, hitherto mostly lumped together as alluvium. The igneous origin of trap was adopted from Hutton, Playfair, and Daubeny. Yet at this same time Silliman calculated that the Noachian flood must have risen in America at the rate of 700 feet in 24 hours, on the assumption that the mountains were about  $5\frac{1}{2}$  miles high and were submerged by 40 days' rain, with the help of a deluge from the bowels of the earth. The flood proved fatal to the Siberian mammoth and did much other damage.

Silliman, as Huxley put it, wrote "with one eye on fact, the other on Genesis."

Chapter iii. introduces the first of five decades of State Surveys, and deals with the years 1830-39. Eaton produced a text-book early in this period, and still strove to harmonise all phenomena with the Biblical account. Sixteen State Surveys were founded, nine of them in the years 1836-40. The number of State Surveys founded in the five decades may surprise British geologists, but it must be remembered that though some of the pioneers had had the intrepidity to attack the wild alone, organised bands of independent resources and capable of self-defence were essential. The object appears generally to have been the exploiting of rocks and minerals of economic value.

During the second decade, 1840-49, geology found a place in educational curricula. The Society of American Naturalists and Geologists was formed in 1847, but was afterwards merged in the American Association for the Advancement of Science, at the first meeting of which geologists took a prominent part. It may be noted that the Geological Society of London had been founded in 1807, and readerships in geology at Oxford and Cambridge in 1813 and 1808 respectively. During the decade much progress was made in the recognition in the United States of the principal formations of Europe. The interpretation of the structure of the Appalachian Chain by the two Rogers was a notable achievement. In the final report (not published until 1858), H. D. Rogers distinguished hypozoic, azoic, and palæozoic, and divided the last into formations named after the period of a day, such as auroral, vespertine, etc., but the European names, Cambrian and Silurian, were preferred. He also enunciated his well-known views on the formation of coal and anthracite, but above all he described what is now known as the "overthrust fault." James Hall's views on palæontology at this time are worth recording. "Changes in the lithological features of a rock . . . are usually accompanied by a greater or less change in the nature of the fossils. In no case, therefore, are to be overlooked either of the three important facts and characters, viz., lithological character, order of superposition, and nature of contained fossils." He is credited with having written not less than 10,000 pages, and either this or something in his methods roused the antagonism of nearly every palæontologist in America. Dana began to publish in this decade.

The third decade (1850-59) was marked by financial depression and starvation of State Surveys. It was notable for a report by Evans on the Bad Lands, previously almost unexplored. In the vast labyrinth of defiles the bones of extinct animals lay in profusion.

Leidy's description of Evans's specimens was the first systematic account of the world-famed Bad Lands fossils. Emmons, Dawson, and Hitchcock were publishing in the United States; Murchison was bringing out "Siluria," and Lyell his 9th edition of the "Principles," in Europe.

In the earlier part of the fourth decade (1860-69) the Civil War temporarily stopped work, but State Surveys were resumed in 1864. Dana's "Manual" appeared during this decade. In 1859 petroleum had been found in a well at Titusville. Sterry Hunt pointed out that petroleum by virtue of its lightness would be found in the crests of anticlinals, a guiding principle in the search for oil to-day. The fifth decade brought further developments in natural gas and oil. Marsh, at his own expense, collected vertebrates in the Western States, among these the remains of toothed birds and extraordinary dinosaurians. Stevenson wrote on the Alleghanies and the origin of coal. Chamberlin, dissatisfied with petrological nomenclature, proposed abbreviations, such as *qua* for quartz, *fel* for felspar, *mi* for mica. Thus a mica-granite became *fel-qua-mi* or *mi-fel-qua* according to the predominance of the constituents. The names were rejected as uncouth, but for sheer monstrosity it would be hard to beat some of the latest names, such as *phyrowyomingose* or *hornblende-trach-phyro-monzonose*.

The second Survey of Pennsylvania in 1874-87 under Lesley emphasised the magnificence of the structures and the great development of Palæozoic rocks in that part of the United States. Lesley, who was outspoken, referring in one of his reports to the chaos that must have prevailed in earliest Archæan times, remarked, "All this . . . is only known to God and Dr. Sterry Hunt, who has described it magnificently."

Chapter viii., dealing with the era of National Survey, opens with words that appeal warmly to us, with the War fresh in our memories. "The period of the Civil War had brought to light a considerable number of men for whom the piping times of peace . . . afforded insufficient opportunities. They were men in whom the times had developed a power of organisation and command. They were, moreover, men of great physical and moral courage." This was the material Hayden found available for his territorial surveys, King for his survey of the 40th parallel, Powell for his exploration of the Rocky Mountains, and Wheeler for his work west of the 100th meridian. The expense, however, of keeping so many separate surveys in progress, with inevitable overlapping, impressed on Congress the necessity for consolidation. In 1879 the United States Geological Survey was founded, a service which is unsurpassed for organisation, efficiency, and wideness of scope.

The controversies on fossil footprints and on Logan's Eozoon form the substance of Chapters ix. and x.

Chapter xi. gives the history of the Laramie Question. The Lignitic beds of Hayden, which occupy vast areas, yielded Tertiary plants and Cretaceous dinosaurs. Thus rose a dispute as to the relative value of plants and animals for purposes of correlation. It was pointed out that Cretaceous rocks in Nebraska yielded a flora that had been referred to the Miocene, and again it was suggested that the evolution of plants had been more rapid in America than in Europe, and that this explained the association of European Tertiary plants with American Cretaceous animals. Eventually the name Laramie was restricted to certain beds which were agreed to be Upper Cretaceous.

The Taconic Question, to which Chapter xii. is devoted, occupied men's minds for half a century, and covered the period of the Sedgwick-Murchison controversy on the same formations. Emmons founded the "Taconic System" and declared it to be older than the Potsdam Sandstone. Others disagreed, but Barrande, on the strength of the trilobites, though without knowing the ground, supported Emmons. Dana and Walcott eventually established the true sequence, which had been completely obscured by faults and folds. The "Taconic" of 1842 was distributed among the Lower Cambrian and Lower Silurian of 1903.

Chapter xiii. gives an account of the development of glacial theories. They commence with talk of convulsions, earthquakes, eruptions, etc. Then the Noachian flood was called in to account for everything. But in 1825 Peter Dobson, a cotton manufacturer, made some truly remarkable observations. He noticed that the boulders had been worn smooth and striated on their under sides, as though they had been dragged in one steady position, and he assumed that they had been held and dragged in ice. He could tell also which end had been foremost by the little ridge extending behind any projecting knob of hard material such as quartz. These brilliant deductions attracted no attention until 1842, when Murchison congratulated "American science in having possessed the original author of the best glacial theory." The greatest advance, however, was due to Agassiz, who arrived in America in 1846 and there developed the views he had formed in Switzerland.

Chapter xiv. relates how the method of micro-petrology as initiated by Sorby and developed by Zirkel, was adopted in America in 1873 and became officially recognised as a necessary part of the equipment of a State Geologist.

Chapter xv. on the age of the earth deals with the estimates made by Hutton, Lyell, Playfair, Reade, and

G. H. Darwin in Britain and those of Winchell, Walcott, King, and Gilbert in America. The American estimates varied greatly, but were all far smaller than those made in Europe. Burrell in 1917 restored the balance by an estimate more than three times as large as any of them.

In laying down this book an impression remains of the immense labour which the collecting of such a mass of material must have entailed. The mass indeed is too rich for easy digestion and might have been the better for a little boiling down and arrangement in the earlier chapters. Still the information is all there, available for any one who has the leisure to look for it. The book has been published on the Philip Hamilton McMillan Memorial Fund, and, as the first fruits of her bequest, must be a source of gratification to Mrs. McMillan.

A. STRAHAN.

### The Brauner Jubilee Volume.

*Recueil des travaux chimiques des Pays-Bas.* Publié par la Société Chimique Néerlandaise. Tome 44 (4<sup>e</sup> Série, T. 6), No. 5, Mai. *Numéro jubilaire en l'honneur du Professeur Bohuslav Brauner, publié par ses amis et élèves en commémoration de son 70<sup>e</sup> anniversaire, 1855—8 Mai—1925.* Pp. 281-628. (Amsterdam : S.A. d'Éditions scientifiques D. B. Centen, 1925.)

NUMEROUS friends and pupils of Prof. Bohuslav Brauner, the illustrious Director of the Chemical Institute of the Charles University of Prague, have signalled his seventieth birthday by issuing this splendid volume of researches in his honour. It opens with a most delightful "Hommage au Professeur Bohuslav Brauner" written by Prof. Urbain and entitled "Discours sur les éléments chimiques et les atomes." In this brilliant essay, the author, in tracing the development of scientific research concerning the chemical elements and the nature of the atoms, shows the fundamental character of Prof. Brauner's work in the fields of the rare earths, the atomic weights, and the Periodic System of Mendeléeff. Whilst every one is familiar with Prof. Brauner's long and splendid series of researches on the atomic weights, it is well that the younger chemists of the present generation should be reminded of the fact that he it was who discovered that the old "didymium" was in reality a mixture of two elements, neodymium and praseodymium.

The present volume bears ample witness to the fact that Prof. Brauner has done much more than greatly to advance the science of chemistry by his own researches. He has created and built up a great school of chemical research in the land of the Czechs.

On the cover of this Jubilee volume there is a picture of the fine Chemical Institute which was founded by his efforts in 1903, whilst the 348 pages contained between the covers include a large number of very interesting researches carried out by his present and former pupils. Although it may appear perhaps a little invidious to single out any of these for special praise, attention may be directed to the series of ten investigations with the dropping mercury cathode, published by Dr. Heyrovsky (professor of physical chemistry in the Institute of Prof. Brauner) and his collaborators.

Amongst the papers contributed by foreign chemists, one is very glad to see that there are two from England, namely, Prof. H. B. Dixon's investigation on "The Ignition of Carbon Disulphide Vapour and its Phosphorescent Flame," and a paper by Dr. J. G. F. Druce on "The Stannonic Acids and Some of Their Derivatives. A New Series of Organic Compounds of Tin."

On his impending retirement from the active direction of the Chemical Institute at Prague, Prof. Brauner will carry with him not only the affection and esteem of his many pupils, but also the highest respect and admiration of chemists all over the world. For upwards of half a century he has held high the torch of science and true learning, and in the annals of chemistry his name and his work will ever be remembered with honour and gratitude.

F. G. DONNAN.

### British Butterflies.

*Natural History of British Butterflies: a Complete, Original, Descriptive Account of the Life-History of every Species occurring in the British Islands, together with their Habits, Time of Appearance, and Localities.* By F. W. Frohawk. Vol. 1. Pp. xv+207+36 plates. Vol. 2. Pp. iv+206+29 plates. (London: Hutchinson and Co., 1924.) 6l. 6s. net.

M R. FROHAWK is well known to naturalists as an admirable delineator and accurate observer of British lepidoptera in all their stages. The present work amply fulfils the expectations of those who knew that the author was engaged upon the task of describing and figuring every British butterfly in all its phases from egg to imago. The work may fitly be termed monumental; for it represents an immense amount of patient labour carried on through a long series of years, and accomplishes what has never been attempted before, namely, a complete life-history of every species of butterfly that has any claim to be considered British. The ground has been partly covered by the works of Barrett, Buckler, and others, but never before has

the assemblage been figured and described as a whole.

The most characteristic feature of Mr. Frohawk's two splendid volumes is the exact and careful description of each larval form in every period of its growth. These details have in all cases been worked out from actual living specimens, and the amount of labour involved in the completion of this task can only be fully appreciated by those who have experimented in the same field. In the case of species that are now extinct in Britain, such as *Chrysophanus hippothoe* and *Zizera semiargus*, or of occasional visitors such as "*Pieris*" *daphnidice*, *Argynnis lathonia*, *Vanessa antiopa*, and *Anosia archippus* (*plexippus*), Mr. Frohawk has made use of eggs laid by females obtained from abroad. In spite of all difficulties, the industry and skill of the author have proved equal to the enterprise of describing and figuring, in all these instances, every stage from egg to perfect insect.

It is well known to all students of the lepidoptera that the life-history of the "Large Blue" (*Nomiades arion*) was a mystery which eluded solution by the efforts of every entomologist until the successive discoveries of Mr. Frohawk, the late Dr. Chapman, and Captain Purefoy furnished the key to the puzzle, namely, the extraordinary relations that exist between the larval *arion* and certain species of ant. Of this association an excellent account is given on pp. 144-149 of the present work, and a striking figure, sketched from life, of the larva signalling to the ant when ready to be carried off to the nest of the latter, is provided on a separate plate. It is noteworthy that German larvæ of *C. hippothoe* kept out of doors in England were visited by ants. Many points of bionomic interest in connexion with other species are mentioned in the text.

The artistic skill of the author is well known, and his beautiful drawings have been, on the whole, worthily reproduced. It may, however, be doubted whether the colour-process adopted is the most suitable that could have been chosen for representing very young larvæ of the natural size. Wing-venation also, in the case of small insects, requires a sharper definition than is to be found in some of the illustrations, e.g. on Plates 56 and 56A.

The style and get-up of these volumes is in the main excellent. A few slips may be noted: fig. 23 on Plate 12 has no legend; fig. 15 on Plate 37, called a female, must be a male; the "Mazarine Blue" is spoken of as *Lycaena acis* on p. x, and as *Zizera semiargus* on p. xi. An appreciative preface to this fine work has been contributed by Lord Rothschild, whose generous co-operation and continued encouragement are gratefully acknowledged by the author.

F. A. D.

## Our Bookshelf.

*Handbuch der Pflanzenanatomie.* Herausgegeben von Prof. K. Linsbauer. Allgemeiner Teil: Cytologie. Band III/2: Die Zellmembran. Von Prof. Dr. C. van Wisselingh. Pp. viii+266. (Berlin: Gebrüder Borntraeger, 1924.) 15 gold marks.

BOTANISTS will welcome a general survey on the plant cell membrane from the pen of the Groningen veteran, Prof. C. van Wisselingh. Inequalities of treatment certainly suggest themselves to the English reader when the chemistry of cellulose is handled without citation of Irvine and its physical structure discussed without reference to W. L. Balls (one recent paper is quoted in the appendix); but there is very real compensation in the individual treatment the problems of the cell wall here receive from the viewpoint of a master of micro-chemical method, who avails himself when necessary of the results of as yet unpublished researches.

The usual plan followed in the monograph is a preliminary account of the chemistry of a wall substance, followed by a discussion of its distribution in the cell wall throughout the plant kingdom. As would be expected from the author, the treatment of suberin and chitin is particularly complete, but it is doubtful whether the reactions of the lignified wall have ever been so fully stated before, and the section upon the chemistry of the pectin substances is very full and up-to-date.

Mangin regarded cellulose, pectin, and callose as the three fundamental substances of the plant wall; the importance of pectin is now fully admitted, but van Wisselingh considers that the case for the identity of callose has yet to be made out. For all fat impregnated walls the author reports a new micro-chemical method. Sections are warmed in baryta water for some hours, so that baryta soaps are formed; acids are then released from these and the melting-points of the acids observed with the sections mounted in glycerine.

The section upon the structure and growth of the cell wall is entirely inadequate as a bibliographic treatment, but contains a most interesting statement of the author's own views, in which stress is laid upon the chemical heterogeneity of the wall and the possibility of its micro-chemical demonstration.

*Sturly.* By Pierre Custot. Translated from the French by Richard Aldington. Pp. 127. (London: Jonathan Cape, Ltd., 1924.) 5s. net.

THE zoologist does not need the aid of a poetic imagination to appreciate the wonderful panorama of marine life with its hosts of interesting phenomena and many absorbing problems. Yet it is not surprising that these things should have stirred the imagination of a man of letters and moved him to weave this delightful phantasy, with a sturgeon as the central figure, and the world of marine zoology as the setting. M. Custot has read widely and well, and has supplemented his extensive reading by constant observation of marine animals in the aquaria at Monaco. *Sturly*, the hero of this fairy tale, is a young sturgeon, born in the waters of the Rhône, whose life, from the time of his enthusiastic and unsophisticated youth to the crowning act of reproduction, is charmingly told.

His adventures among the denizens of the seas during his migratory periods, his impressions of the beauty of form and colour, the phenomena of symbiosis, commensalism and parasitism, the phosphorescence of the deep sea animals, the bizarre form of others and the art of protective resemblance are made the means of introducing the reader to a survey of the whole field of marine life, pelagic, littoral and deep sea. Sturly, under the guidance of a hoary, wise, old Echinus, sets out to probe the mystery and meaning of life, and the steady development of his education to a realisation of that inexorable law of Nature, reproduction of the kind, forms the real theme of the book.

The bitterness produced by the results of his search are removed by the advent of death when a voice from another world soothes his last hours in this, by a promise of a reincarnation and a fuller life in the next. Thus does Sturly solve the meaning of life. We can forgive the author a few minor zoological errors such as the occurrence of *Convoluta* at 100 fm., the presence of *Melia tessellata* in the Mediterranean, and the description of a copepod as a wood-louse, in the real charm and simplicity of his allegory. The book was worth translating, and Mr. Aldington has done his work well in face of the many technical difficulties involved in finding the right English equivalent for the many unusual names of animals in the original. The book should stir the reader to a desire for an extended knowledge of marine life.

*British Museum (Natural History). Fossil Insects*, No. 1: *The British Liassic Dragon-flies (Odonata)*. By Dr. R. J. Tillyard. Pp. 40+5 plates. *Fossil Insects*, No. 2: *Insects from the Coal Measures of Commentry*. By Dr. Herbert Bolton. Pp. 56+3 plates. (London: British Museum (Natural History), 1925.) 5s. each.

THESE memoirs mark a new departure in the publications of the British Museum. Instead of waiting for the time when it would be possible to issue a descriptive catalogue of the entire collection of fossil insects, it has been decided to publish shorter memoirs on portions of the collection whenever specialists can be found to undertake the work. The first two memoirs of the series are written by palæontologists not officially connected with the Museum.

The dragon-flies described by Dr. Tillyard are from the Lias of Leicestershire, Warwickshire, Worcestershire, and Gloucestershire—mainly from the "Insect Limestone" of Lower Liassic or perhaps in part of Rhætic age. The larger number of the specimens were collected by the late Rev. P. B. Brodie. Nearly all the species belong to the sub-order Anisozygoptera, which at the present day is represented by a single genus with two species, one found in Japan, the other in the Himalayas.

The Coal Measures of Commentry in the central plateau of France have yielded an abundant and varied insect fauna, ranging from primitive forms to specialised types regarded as the forerunners of dragon-flies. Nearly all possessed a great span of wing relatively to the size of the body. It is pointed out that only very rarely are two or more insect wings alike in venation—an indication perhaps of rapid evolution in Carboniferous times. Both memoirs are well illustrated with plates and text-figures.

*Perseus: or, Of Dragons*. By H. F. Scott Stokes. (To-day and To-morrow Series.) Pp. 80. (London: Kegan Paul and Co., Ltd., 1924.) 2s. 6d. net.

To any who wish to read pleasantly of dragons, this book may be commended. The author ranges with a gossiping humour from Glastonbury to ancient Egypt, devoting some attention to Perseus, St. George, the dragons of Rhodes and Bologna, and other dragons of modern Europe by the way. He begins with a chapter on the characteristics of dragons, touches upon the folk-lore themes which occur in dragon stories, such as the supernatural birth, the life-token, the magic weapon, and the rescued maiden, and concludes with a summary of Elliot Smith's theories of the diffusion of culture from a common origin. Incidentally to his reference to the theory that the dragon is a folk-memory of antediluvian monsters, notwithstanding the chronological discrepancy, it may be mentioned that it has been suggested in all seriousness to the present writer that the long-necked dance masks shown in Capt. Hurley's recent film "Pearls and Savages" is a reminiscence of the plesiosaurus!

*Leaves from a Naturalist's Diary: with Notes on What to Look for Month by Month*. By A. R. Horwood. Pp. 192+4 plates. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1924.) 3s. 6d. net.

MR. HORWOOD has written a nature study book in the form of a calendar. Interesting or salient points in Nature's yearly cycle are dealt with month by month in separate chapters, and at the end of each chapter is a list of the more important and commoner animals and plants to be found in suitable places during that month. This is the most valuable part of the book, and Mr. Horwood has in some cases given his mere list an ecological value by specifying the kind of habitat in which to look for the species listed. Such lists cannot be expected to be complete, but as a guide to the Nature lover they are useful and should also serve as a basis for a diary in which actual records and other data can be kept by observers. This brief survey of the pageant of Nature for a year is pleasantly written in simple and easy language, and illustrated by four photographs and many quite life-like sketches of typical animals and plants.

*The Travel Diary of a Philosopher*. By Count Hermann Keyserling. Translated by J. Holroyd Reece. Vol. 1. Pp. viii+336. Vol. 2. Pp. 405. (London: Jonathan Cape, Ltd., 1925.) 36s. net.

COUNT KEYSERLING'S reflections on the various modes in which human speculative thought has found expression, and his study of the distinctive character which climate and the aspect of Nature in the different countries of the world has impressed on man's religious and ethical feelings, can now be read by the English student in an excellent translation. The book is delightful to read, on account of the extraordinary power of the author to project himself sympathetically into the most opposite modes of thought. The publication of the original work was interrupted by the War, and that disastrous upheaval, with its outburst of hatreds, casts its shadow over a philosophy conceived in the spirit of peace on earth among men of goodwill.

## Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

## On the generally accepted Explanation of the Zeeman Triplet on a Quantum Basis.

THE explanation of the simple Zeeman triplet on the basis of the quantum theory ostensibly depends on the application of Larmor's theorem.

This theorem may be expressed as follows:

Suppose a system of electrons describing orbits under the action of their mutual repulsions combined with any other forces the directions of which pass through an axis. Then if the system be subjected to the action of a uniform magnetic field  $H$  along that axis, the motion of the system is such that it may be represented as a possible motion with  $H=0$  combined with a precessional rotation as a whole around the axis. When the other forces are central this applies to any direction of  $H$  as axis.

In the usual way of applying this theorem to the explanation of the Zeeman effect, the tacit assumption<sup>1</sup> is made that after the imposition of the magnetic field the rotating system is the *same* as before with simply the rotation superposed. This assumption is not only incorrect but would also seem open to two further objections, in that (1) the new orbit ceases to be quantised and (2) the total energy is supposed to be altered by the action of a magnetic field on a moving electron.

That the assumed new orbit ceases to be quantised is easily seen by considering a special case of, say, a circular orbit with its plane perpendicular to the magnetic force. The new path is assumed to be unchanged, but the velocity of the electron to be changed by the Larmor effect (which of course agrees with that calculated from the changed radial force  $Hev$ ). The orbit therefore ceases to be quantised and the quantum law is disobeyed.

It would seem that the most natural way to attack the problem would be by first attempting a discussion of actual orbits. Unfortunately, however, this shows that no effect is to be expected—or if so the magnitude must depend on the square or higher powers of  $H$ . We can easily see this by the following considerations of simple cases.

1. Let us suppose the field is imposed by a very gradual increase from zero. The orbits of all electrons will gradually change. As the change is slow we have an adiabatic process and the new orbits will all remain quantised if the original were. But the magnetic field acts transversely on the moving electric charges, and the total energy will therefore remain unchanged. There is thus on the quantum theory no Zeeman effect.

2. Let us suppose the field already constituted and take the case of a circular orbit round a central force in a plane perpendicular to the field  $H$ . Then with the usual nomenclature

$$m\omega^2 r = \frac{e^2}{r^2} \pm He\omega r, \quad W = \frac{1}{2}m\omega^2 r^2 - \frac{e^2}{r}, \quad 2\pi m\omega r^2 = nh.$$

From the first

$$\frac{e^2}{r^2} = m\omega^2 r \left(1 \pm \frac{He}{m\omega}\right).$$

If we neglect squares of the small quantity  $\pm He/m\omega$  ( $=x$  say) we may replace the  $\omega$  in  $He/m\omega$  by

<sup>1</sup> Larmor (see "Aether and Matter," p. 343), however, in stating his theorem expressly gives a warning against this assumption.

its value when  $H=0$ . Substituting for  $\omega$  from the third we find

$$\begin{aligned} \frac{I}{r} &= \frac{4\pi e^2 m}{n^2 h^2 (1-x)}, \\ W &= \frac{e^2}{r} \left( \frac{1}{2} \frac{I}{1-x} - 1 \right) = \frac{4\pi^2 e^4 m}{n^2 h^2 (1-x)} \left\{ \frac{1}{2} \frac{I}{1-x} - 1 \right\} \\ &= -\frac{2\pi^2 e^4 m}{n^2 h^2} \frac{1-2x}{(1-x)^2} = -\frac{2\pi^2 e^4 m}{n^2 h^2} \end{aligned}$$

neglecting  $x^2$  . . . But this is Bohr's value for no field. As this remains unchanged there is no Zeeman effect.

From the above considerations it would appear that the true explanation of the Zeeman effect on the quantum basis yet remains to be given. Doubtless it is to the nucleus that we must look for this. Should, for example, this contain structures analogous to permanent magnets a change of energy by an impressed magnetic force is possible. But it is not the object of the present note to go into this further question.

W. M. Hicks

On the reported  $K\beta_4$  Line in the X-ray Spectra of Molybdenum and Palladium.

In a recent publication A. Leide (*Compt. rend.* 180, p. 1203 (1925)) has reported the results of an investigation of the wave-lengths in the  $K$  series of X-rays for elements having atomic numbers between 29 (copper) and 53 (iodine). The spectrograph used had a high resolving power so that the  $\beta_4$  line was separated into its components. The accuracy was increased by a large number of exposures for each measurement. In addition to the well-known lines  $\alpha_1$ ,  $\alpha_2$ ,  $\beta_1$ ,  $\beta_2$  and  $\gamma$  or  $\beta_3$ , he has reported in the case of molybdenum (42) and palladium (46), a line  $\beta_4$ , ascribed to the transitions  $O_{II}$ ,  $O_{III} - K$ .

Such transitions are permitted by the principles of selection, but transitions from  $O_I$  to  $K$  are prohibited. The schemes of electron distribution advanced at present (Bohr, Stoner) place no electrons in the  $O_{II}$ ,  $O_{III}$  sub-levels in the normal states of the molybdenum and palladium atoms, but these elements lie in a portion of the periodic table where inner levels are presumably being filled up as electrons are added, admittedly making the actual electron distribution doubtful in the outermost levels. The presence of this  $\beta_4$  line for these atoms would lead to the following alternatives: Either the  $O_{II}$  and  $O_{III}$  levels contain electrons before the first 18 electrons have entered the  $N$  shell, or we are here dealing with "semi-optical" X-ray lines, i.e. electron transfers from virtual orbits only occupied by electrons in atoms excited in the optical sense. Such orbits would presumably be greatly distorted in the atoms in a solid substance. Such semi-optical lines have been previously mentioned by Siegbahn and his co-workers (*Phil. Mag.* 49, 513 (1925)).

It has occurred to me that there may be some uncertainty as to the existence of this line in the  $K$  series spectra of molybdenum and palladium. Recently in this laboratory, in collaboration with Miss Alice Armstrong, a rather extensive reinvestigation of the molybdenum  $K$  series spectrum has been carried out, using an ionisation spectrometer. Some of the results of this work were reported to the American Physical Society at its spring (1925) meeting. In the course of the investigation no evidence was found for the presence of this  $\beta_4$  line described by Leide, though readings were taken in that region of the spectrum in which it should occur. In this region, however, a discontinuity in the white or general radiation always appeared, due to the absorption by

the target of its own radiation. This showed itself, for example, in the first order by the fact that the base-line due to general radiation was always much lower on the short wave-length side of the  $\gamma$  line than on its long wave-length side.

This absorption by the target of the radiation which leaves it has been mentioned by other authors, including Walter (*Zs. f. Physik*, 20, p. 268 (1923)). This effect of the  $K$  critical absorption in the target substance would produce, in spectra of high resolution, a narrow shelf of constant intensity on the short wave-length side of the  $\gamma$  line, followed by a large decrease in intensity on the short wave-length side of the critical absorption wave-length, which is very close to the  $\gamma$  line. It seems possible that such an effect might be mistaken for a faint line on the short wave-length side of  $\gamma$ , lying between  $\gamma$  and the critical absorption wave-length. The lines reported by Leide were very faint and the wave-lengths given lie within 0.06 per cent. (about 12 seconds of arc) of the accepted values for the  $K$  critical absorption limits. The  $K$  critical absorption wave-length lies about 45 seconds of arc from the  $\gamma$  line in the first order. Due to the importance which may be attached to the presence of this line in molybdenum and palladium, it is to be hoped that the possibility of confusion on the photographic plate with the absorption limit itself may be removed.

SAMUEL K. ALLISON.

Jefferson Physical Laboratory,  
Harvard University,  
Cambridge Mass., U.S.A.

#### A Substitute for a Liquid Air Trap for Mercury Vapour in Vacuum Systems.

As is well known, the speed and simplicity of the mercury vapour condensation pump has led to its almost universal adoption in the production of extremely high vacua. It suffers from the disadvantage that, while it rapidly removes gases and vapours from the vessel to be exhausted, it does not remove mercury vapour. Consequently, it is necessary to freeze the mercury vapour in a trap between the pump and vessel to be exhausted, by immersing the trap in liquid air. The cost of making liquid air, the difficulty of getting it in certain laboratories, and, in some researches, the need for keeping the mercury trap in action for several weeks without a break, suggested the desirability of looking for some alternative method.

In our search for an alternative method, we have found that the alkali metals have an extraordinary power for absorbing mercury vapour, and may therefore be used as a mercury trap in place of liquid air. Our practice is to put a small piece of sodium or potassium (a gram is ample) into a trap between the diffusion pump and the apparatus to be exhausted, and to distil it, after the vacuum has been obtained, on to the sides of the trap, thus lining it with the metal for a few centimetres. The trap may be of the usual liquid air type, or it may be merely a bent tube with the metallic lining of distilled metal distributed over the inside surface at and near the bend.

Using an ionisation gauge for the vessel to be exhausted, we have found that the pressure of mercury vapour in it with a potassium-lined trap between it and the pump is certainly less than  $5 \times 10^{-9}$  mm. We have made direct comparisons between the trapping power of a potassium-lined tube and that of the usual liquid air trap, the same ionisation gauge measuring the pressure reduction. We have found that the potassium-lined trap is quite as satisfactory as liquid air. The residual pressures obtained in various tests seem to depend entirely upon the vigour

with which the ionisation gauge and connecting tubes were outgassed by heat treatment before the measurements were made, and not at all upon whether liquid air or metallic potassium is used to trap the mercury. We are convinced that the lowest pressure obtained, namely,  $5 \times 10^{-9}$  mm., is partly, and possibly entirely, due to residual gases owing to insufficient heat treatment, and that this figure is merely an upper limit to the vapour pressure of mercury in a vacuum system beyond a potassium-lined trap.

The passage of several litres of moderately dry air at atmospheric pressure over the potassium has no serious effect on its power to trap mercury vapour, although one might well have feared such would be the case from the discolouration of the surface produced by the air.

From a practical point of view, it is of importance to know how long the alkali metals retain their power to act as a mercury vapour barrier. In one test, in which sodium was the active metal, the pressure in the ionisation gauge beyond the trap after twenty-five days was within 50 per cent. of its initial value ( $2 \times 10^{-7}$  mm.). We do not know whether to attribute this slight pressure increase to loss of absorbing power by the metal, or to gradual evolution of gas.

In a second test, we used the first appearance of mercury lines in the spectrum of helium, at less than 0.01 mm. pressure, as a criterion of the diminution of the trapping power of a potassium-lined trap for mercury vapour. The mercury lines did not appear until the eleventh week, in which time the potassium had absorbed a little more than 150 per cent. of its own weight of mercury.

A full account of this work will be published in the *Philosophical Magazine*.

A. LL. HUGHES.

F. E. POINDEXTER.

Washington University,  
Saint Louis, U.S.A.,  
May 18.

#### The Oogenesis of Lumbricus.

IN a recently published number of the *Quarterly Journal of Microscopical Science*, Mr. Leslie Harvey, of the department of zoology of the Imperial College of Science, London, has given an account of the cytoplasmic inclusions of the egg of *Lumbricus*. Mr. Harvey describes yolk formation in this animal, and, on the basis of his work on this one form, criticises my previous investigations on *Limnæa*, and, by inference, that of my pupils on certain other forms. He merely quotes an old paper of mine, remarking a little discourteously that "a glance at this paper will show that really very little is known about the formation of yolk." He has not mentioned my recent work on *Saccocirrus*, the only other annelid studied by modern methods, nor has he read Dr. Rogers Brambell's more recent paper on "Yolk" in the *British Journal of Experimental Biology*, where the collected observations of several of my associates are discussed fully, the molluscan oogenesis re-investigated, and the general views on yolk-formation held in this laboratory stated.

Mr. Harvey's main criticism is that he cannot find any metamorphosis of Golgi bodies into yolk in *Lumbricus*, and that therefore my work on *Limnæa* and that of my pupils on *Patella* is under suspicion. Mr. Harvey puts himself in the position of a man who, on the strength of a study of the anatomy of *Lumbricus*, denies the results of another man who has found a radula and a shell in *Patella*. Before entering into a criticism of my work on *Patella*, which has been confirmed and extended by Dr. Ludford and Dr.

Rogers Brambell, he should have examined that form itself, or some other such mollusc.

Regarding the special question of the oogenesis of *Lumbricus*, it is remarkable to note that Mr. Harvey has hit upon one of those rather uncommon animals that have no proper vitellogenesis. The egg of *Lumbricus* has no real yolk, but the embryo is nourished in the cocoon by some albuminous substance. It is therefore doubly unfortunate that Mr. Harvey should discredit my work, and that of my associates, on the results obtained by the study of this special atypic annelid. Moreover, had Mr. Harvey read my results on *Saccocirrus*, he would have noted that I did not claim in that animal that yolk arose from the Golgi elements. Regarding the origin of yolk from Golgi elements, I may mention that Dr. P. Weiner, of the histology laboratory of the University of Leningrad, recently wrote to me that in *Myriapoda* and *Arachnoidea* "he had occasion to observe the starting of yolk granules in contact with particles of the Golgi apparatus," and in this connexion some *Julus* preparations which I have just seen support Dr. Weiner's interpretations. Mr. Vishwa Nath claims that in *Lithobius*, and *Palamnaeus*, fatty yolk arises from the Golgi elements. In the *Julus* preparations of Mr. Vishwa Nath the Golgi elements of the egg are found to swell up in a specially definite manner, which is not seen in anything like the same degree in *Lithobius*, where both Miss King and Mr. Vishwa Nath agree that the heavier yolk is nucleolar in origin.

The complete details of the behaviour of the Golgi apparatus of the *Lumbricus* oögonium and oocyte, and a discussion on the cytoplasmic inclusions in the eggs of molluscs, annelids, and arthropods, will shortly be given in a joint paper by Mr. Vishwa Nath and myself.

J. BRONTÉ GATENBY.

Trinity College, Dublin,  
June 4.

### Band Spectra of Lead Isotopes.

No satisfactory explanation seems to have been given as yet of the measurements made by Grebe and Konen (Grebe and Konen, *Phys. Zeits.*, 22, p. 546 (1921)) on the band spectra of lead isotopes. They observed that, in the case of uranium lead, the lines of the band at 4270 showed an average shift to the violet of 0.055 Å, as compared with those of ordinary lead, and that the lines were much sharper in the former case than in the latter.

A very satisfactory explanation is obtained if the carrier of the band is assumed to be, not the heavy  $\text{Pb}_2$  molecule, but the lighter  $\text{PbH}$  molecule. The success of Kratzer (Kratzer, *Ann. d. Phys.*, 71, p. 70 (1923)) and of Mulliken (Mulliken, *Phys. Rev.*, 25, pp. 119, 509 (1925)) in accounting for the bands in the spectra of certain metals on the assumption of a hydride molecule seems to favour the same assumption in the case of lead.

Applying the theory first proposed by Loomis (Loomis, *Ast. phys. Jour.*, 52, p. 248 (1920)) to explain the complex structure of the band spectrum of hydrogen chloride, one obtains, for the wave-length difference between the bands of the hydrides of uranium lead (At. Wt. 206.0) and ordinary lead (At. Wt. 207.2),

$$\frac{d\lambda}{\lambda} = \frac{1}{2} \left( \frac{1}{206} - \frac{1}{207.2} \right) = 1.4 \times 10^{-5}.$$

Since  $\lambda = 4270$  Å, the expected shift is 0.060 Å, a value in very good agreement with the observations. The lack of sharpness of the lines in the case of ordinary lead is of course connected with the fact

that the atomic weight 207.2 is only a statistical average.

Further, the moment of inertia of the carrier agrees very well with what we should expect for the  $\text{PbH}$  molecule. The frequency of the lines in the band can be written

$$\nu = A + 2Bm + Cm^2 \quad \dots \quad (1)$$

where  $m$  is an integer and

$$B = \frac{h}{8\pi^2 J}, \text{ and } C = \frac{h}{8\pi^2} \left( \frac{1}{J} - \frac{1}{J'} \right),$$

$J$  and  $J'$  being the initial and final values of the moment of inertia of the molecule.

Now the approximate constancy of the frequency difference between successive lines, combined with the fact that  $m$  is always small for the strongest lines of a band, shows that the last term in (1) may be neglected, compared with the second. The mean frequency difference between successive lines is thus equal to  $2B$ . Since the mean wave-length difference is 1.25 Å, we easily obtain, on substituting numerical values,

$$J' = \frac{h}{4\pi^2 \cdot 2B} = \frac{h}{4\pi^2 d\nu} = 8.0 \times 10^{-40}.$$

For  $\text{PbH}$  this gives a distance between nuclei of  $2.2 \times 10^{-8}$  cm. in good agreement with what we should expect from crystal data. The radius of the Pb atom, according to the measurements of Owen and Preston (Owen and Preston, *Proc. Phys. Soc. Lond.*, 35, p. 101 (1923)), is  $1.76 \times 10^{-8}$  cm. To obtain the same moment of inertia with a  $\text{Pb}_2$  molecule we should have to assume an incredibly small distance between nuclei.

We may therefore conclude that the carrier of the lead band at 4270 Å is in all probability the  $\text{PbH}$  molecule.

ETIENNE S. BIELER.

Macdonald Physics Building,  
McGill University, Montreal, Canada,  
May 15.

### Petroleum in Uganda.

My statement, which is quoted in part in *NATURE* for May 23, p. 815, in the columns of Research Items, under the title "Petroleum in Uganda," with reference to large quantities of oil in the Albertine depression is, I fear, on account of its separation from the context, the omission of seven words and the contributor's remarks upon it, likely to be misunderstood by those who have not read my report, and indeed may possibly deter some from reading the report at all.

I am well aware that the mere occurrence of seepages can never be any criterion of the existence of recoverable supplies; but in that part of the report from which the quotation is taken I am discussing oil formation, not oil accumulation, upon which successful exploitation depends. The results of our chloroform tests (referred to in the seven words missing from the quotation) are sufficient to establish the validity of my general statement as to quantity, quite apart from seepages: quantity is one thing, a recoverable supply is another.

Because more than one British dependency in Africa is at present trying to decide whether it will or will not have a geological survey, the contributor's supposition expressed in the last four lines of the item under consideration would appear unfortunate. Is it not wise to be hopeful, and to remember that some rift valley oil fields are already known?

E. J. WAYLAND.

MR. WAYLAND clearly shows in his excellent report that petroleum has formed in the Lake Albert depres-

sion, and I quoted from him to this effect. I consider, however, that neither seepage nor positive result of chloroform tests constitutes sufficient grounds on which to discuss "magnitude" of such formation, hence the omission in the quotation of six (not seven) words concerning these tests does not affect my comment. Regarding future prospects of petroleum development in Uganda, I agree with Mr. Wayland that it is wise to hope, since hope (unlike oil) springs eternal, but I still feel that the storehouses of petroleum of which he speaks may prove to be like the famous cupboard of the nursery rhyme, though this may be due to my conceptions of the laws governing distribution of oil within the earth's crust being somewhat different from those of Mr. Wayland. On the other hand, it is to be hoped that those responsible for initiating geological surveys in British dependencies are actuated by wider considerations than the possible chance of finding oil; there are other natural resources in the world besides petroleum, and this, quite apart from an obvious scientific motive, should be adequate economic reason for the governments concerned to follow the good example of Uganda.

THE WRITER OF THE NOTE.

### Paramagnetism and the Electronic Configuration of the Atom.

IN a recent note<sup>1</sup> Foëx has directed attention to the fact that two samples of a paramagnetic salt, well defined chemically and placed in identical conditions, can possess very different magnetic properties, apparently corresponding to distinct states of the paramagnetic ion in the salt. This diversity of the magnetic states has been known for some time for the case of solutions of the salts.<sup>2</sup> Thus a concentrated solution of ferrous ammonium sulphate exists in four states: 26 magnetons with a positive molecular field, 26.5 without an appreciable molecular field, 27 and 27.5 with a negative molecular field.

It now appears that the same salt can exist in two distinct magnetic states also for the solid substance, one with 26 magnetons and a positive molecular field,<sup>3</sup> and another with 27.5 magnetons and a scarcely appreciable negative molecular field.<sup>4</sup> Similarly, anhydrous cobalt sulphate can exist in two magnetic states. Thus the measurements of Théodorides,<sup>5</sup> Ishiwara,<sup>6</sup> and Jackson,<sup>7</sup> all indicate one state with 25 magnetons, while Honda and Ishiwara<sup>8</sup> found a variety with 24 magnetons and a very small positive molecular field.

The differences can scarcely be attributed to experimental errors or to impurities present in the salts. It seems highly probable that these salts can actually exist in two forms which are identical so far as chemical composition is concerned but are different magnetically.

Russell<sup>9</sup> has recently suggested that the active and passive states of iron, nickel, and cobalt may correspond to different structures of the atom. Thus he supposes that, while active iron possesses an electronic configuration of 2, 8, 14, 2 in the 1st, 2nd, 3rd, and 4th quantum orbits respectively, passive iron may correspond to either of the arrangements 2, 8, 13, 3, or 2, 8, 15, 1. Similarly, active nickel may correspond

to the configuration 2, 8, 16, 2, and passive nickel to 2, 8, 17, 1.

It is here suggested tentatively that the different magnetic states of the ions of iron (Fe<sup>2+</sup>) and cobalt (Co<sup>2+</sup>) may also correspond to different internal configurations of the electrons. Thus the ordinary ferrous ion would possess the configuration 2, 8, 14, 0, and the other magnetic state might be produced by the transference of one of the fourteen electrons in the incomplete 3rd quantum orbit to the 4th quantum orbit, or by a redistribution of the 3rd quantum orbit electrons among the various levels, 3<sub>1</sub>, 3<sub>2</sub>, and 3<sub>3</sub>, of this orbit.

If this were the case, it would be expected that the solid salt or solutions of the salt would possess different absorption spectra when existing in the different magnetic states. This point could readily be tested, and the results would serve to confirm or refute the suggestion.

L. C. JACKSON.

The Davy-Faraday Laboratory,  
The Royal Institution,  
London, W.1, May 23.

### A Luminous Spider.

ONE day in Central Burma the trail in the jungle was exceptionally difficult. It was long past noon when I realised that the return journey would be equally long and tiring. Camp lay on the other side of a long range of hills, and there was a short cut from the main trail that would save several miles, but this trail was faint. I reached the supposed cut-off about dusk and followed it upward. Darkness came on swiftly, and my pony began to stumble. Somewhere we had missed the trail, for at intervals I could still glimpse the crest of the hills, and I knew my general direction.

Fireflies sparkled here and there. Presently a few feet away I saw a ball of light as large as one's thumb. It was stationary. Tying the horse, I approached it as carefully as possible, finding it surrounded by thorny bushes. It did not move, and I pressed the brush aside until I was directly over it, and then struck a match. There, in full view, was a spider, its large oval abdomen greyish, with darker markings. Still it did not move, and as the match died out its abdomen again glowed to full power, a completely oval light, similar in quality to that of the fireflies. Remembering native tales of poisonous insects, I wrapped a handkerchief around one hand, parted the brush with the other, and when close enough made a quick grab. Alas! the handkerchief caught on a stick before I could encircle the spider, and my treasure scurried away. I followed as quickly as possible, but the light soon disappeared under stones, brush, or in some burrow, for I never saw it again.

Many nights I searched in the jungle and questioned natives and white officers who had passed through that district, but apparently no one else had reported a luminous spider, nor can I find record of any known elsewhere.

Burmese never leave their houses after dark on account of their fear of spirits, so it is not surprising that the natives had never seen one, but some other traveller may be so fortunate as to capture one of these spiders.

The place where I saw the specimen was between the villages of Kyawdaw and Thitkydaing, Pakkoku District, about one hundred and twenty miles west of Mandalay, Burma, in April 1923.

BARNUM BROWN,  
Associate Curator.

Department of Vertebrate Palaeontology,  
American Museum of Natural History,  
New York City, May 29.

<sup>1</sup> *Comptes rendus*, 1925, 180, 919.

<sup>2</sup> *Ann. de Phys.*, 1921, 16, 174.

<sup>3</sup> *Ibid.*

<sup>4</sup> Measurements of Kamerlingh Onnes and Oosterhuis and of Jackson. See Jackson, *Phil. Trans.*, 1923, 224, 1.

<sup>5</sup> *J. de Phys.*, 1922, 3, 1.

<sup>6</sup> *Sc. Rep. Tohoku*, 1914, 3, 303.

<sup>7</sup> *Loc. cit.*

<sup>8</sup> *Sc. Rep. Tohoku*, 1915, 4, 215.

<sup>9</sup> *NATURE*, 1925, 115, 455.

# The Relations between Sunspots, Terrestrial Magnetism, and Atmospheric Electricity.

By Dr. C. CHREE, F.R.S.

THE existence of a relation between sunspot frequency, or area, and the phenomena of terrestrial magnetism and atmospheric electricity is a question on which a reasoned statement of opinion may be opportune.

Two elements may be connected and yet not stand in a linear relationship. When nothing is known, there are advantages in a graphical method, such as that employed by W. Ellis<sup>1</sup> when comparing diurnal magnetic ranges at Greenwich with Wolf's sunspot frequencies. But when there is reason to anticipate a linear relationship, it is better to use Wolf's formula

$$R = a + bS,$$

where  $S$  denotes sunspot frequency, and  $R$  is a quantity such as the diurnal range of a magnetic element.  $a$  and  $b$  are constants which can be determined by least squares. Obviously  $a$  is the value of  $R$  when  $S=0$ . As the average range of  $S$  between sunspot maximum and minimum approaches 100,  $100b/a$  is a convenient measure of the importance of sunspot influence. In the case of magnetic daily ranges  $100b/a$  usually exceeds 0.5, and not infrequently 1.0. If  $100b/a$  is a small fraction, the sunspot influence, even if real, is unimportant. The closeness with which Wolf's formula fits the observations is measured by the correlation coefficient  $r$ . As  $b$  shows the sign of the correlation, whether positive (*i.e.* element increasing with  $S$ ) or negative, we shall treat  $r$  as a numerical quantity. It cannot exceed 1, which represents a perfect fit. A low value such as 0.3 implies that the sunspot relation is very doubtful.

In the case of terrestrial magnetism, a linear sunspot relation seems fairly established for the range of the regular diurnal variation, whether of declination ( $D$ ), horizontal force ( $H$ ), or vertical force ( $V$ ). Further claims have been made. Thus Leyst<sup>2</sup> believed the secular change of  $D$  to be considerably faster at sunspot maximum than at sunspot minimum, but further investigation has not confirmed this. Declination may be east or west, and numerically increasing or diminishing; thus acceleration of the secular change signifies different things at different places. *A priori* the force components  $H$  and  $V$  seem more likely to possess an 11-year period. Unfortunately, with ordinary instruments,  $H$  and  $V$  determinations are less reliable than those of  $D$ , and it is doubtful whether the annual values available have the accuracy necessary for determining the reality of a sunspot influence, which is certainly not large.

Diurnal range may signify the range of a diurnal inequality based on hourly values, or the difference between the extreme instantaneous values of the day, usually called the absolute range. In most if not all of the earlier work by Wolf, Ellis, and others, range meant the diurnal inequality range, or some analogous quantity. Older data were mostly from eye readings taken at two fixed hours, at Milan, for example, at 8 A.M. and 2 P.M. If the observation hours are the

hours of maximum and minimum in the mean diurnal inequality for the year, they will give in the case of the whole year the same range that hourly readings give. If the hours of maximum and minimum vary in different months, the range derived from hourly readings may in some months sensibly exceed that from readings at two fixed hours. But these are minor differences, and the older observations may be regarded as establishing the validity of Wolf's formula for the mean diurnal inequality of the year. In general,  $D$  was the element considered, but Ellis also included  $H$ . It is not claimed that Wolf's formula with invariable values of  $a$  and  $b$  agrees closely with observation in every year of, say, 50 years. But, so far as is known, whenever Wolf's formula has been applied to any 11 years,  $b$  has proved to be plus, and  $100b/a$  has been substantial. This has been true whether the diurnal inequality has been derived from quiet days or from ordinary days. At Kew the value obtained for  $100b/a$  from the quiet days of 1890 to 1900 was 0.71 for  $D$ , and 1.07 for  $H$ . Ordinary days gave very similar results. Fairly similar results have been obtained at many stations, the value of  $b/a$  being usually decidedly higher for  $H$  than for  $D$ . The fit of Wolf's formula is generally good, and sometimes extremely close. For the period 1911 to 1921, in the case of the mean diurnal inequality at Kew,  $r$  was 0.96 for  $D$ , and 0.95 for  $H$ .

Instead of the range of the mean diurnal inequality for the year, we may take the arithmetic mean of the ranges of the diurnal inequalities for the 12 months. The two quantities usually differ, but similar results are obtained.

Instead of considering the whole year, we may apply Wolf's formula to different seasons, or even individual months of the year. The fit for an individual month, *e.g.* the Januaries of an 11-year period, may be indifferent, but it is usually good for a 4-month season, *e.g.* May to August (summer), or November to February (winter). We may calculate  $a$  and  $b$  from the range of seasonal diurnal inequalities, or we may accept as the seasonal values of  $a$  and  $b$  the arithmetic means of the  $a$ 's and  $b$ 's calculated for the included months separately. The most outstanding result is that, at least in higher latitudes,  $b/a$  is considerably larger for winter than for summer. Thus at Pavlovsk, 1890 to 1900, the value of  $100b/a$  for  $H$  from all days was 1.77 in winter, as against 0.98 in summer.

The absolute daily range is larger than the inequality range, and is more affected by disturbance. It, too, shows the sunspot influence clearly, but with a less close fit of Wolf's formula. An interesting example<sup>3</sup> is afforded by the years 1892, 1893, and 1894, with sunspot frequencies of 73.0, 84.9, and 78.0 respectively. The ranges of the mean diurnal inequalities in  $D$  at Kew for ordinary days were 9.85, 10.7, and 9.8; while the mean absolute ranges from all days were 17.7, 15.6, and 16.5. Thus 1893, the year of sunspot maximum, had the largest inequality range, but its mean absolute range was distinctly inferior to those of the adjacent years. The result appeared in  $H$  as well

<sup>1</sup> Phil. Trans., 171, p. 541.

<sup>2</sup> Bull. de la Société Impér. des Naturalistes de Moscou, 1909, p. 160.

<sup>3</sup> Phil. Trans., A 208, pp. 215 and 226; A 216, p. 261; and Chree, "Studies in Terrestrial Magnetism," pp. 177, 178.

as D, and the order of the inequality ranges was the same for quiet as for ordinary days.

The difference between sunspot maximum and minimum years is partly a matter of disturbance, but both classes of years contain days practically free from disturbance, and the quiet days from sunspot maximum years tend to have larger ranges than the quiet days from sunspot minimum years. The relation between sunspots and magnetic disturbance is much less definite than that between sunspots and the regular diurnal inequality. In a general way, disturbance is least at sunspot minimum. In the 11 years 1890 to 1900 at Kew there were 29 (Greenwich) days with H absolute ranges not less than 250γ, but none of these occurred in the three years nearest to a sunspot minimum. On the other hand, some years of many sunspots are also quiet. For example, 1893, a year of sunspot maximum, had no H range so large as 250γ, while 1892 and 1894 between them had 24 such ranges. Again, some of the very largest magnetic storms have occurred in years of comparatively few sunspots. Thus 1921, with a sunspot frequency little more than half that of the average year, had a succession of highly disturbed days during May, to which the previous 60 years afforded only one parallel.

The existence of a specific relation between individual sunspots and individual magnetic storms is a vexed question, on which a general agreement cannot be claimed. The magnetic character of an individual day certainly cannot be inferred from the sunspot area or frequency for the day. The 660 selected quiet days of the 11 years 1890 to 1900 had 41.15 as their mean provisional sunspot frequency, as compared with a mean of 41.03 from all days of the year. When the 5 days of highest sunspot area from each month of these 11 years were considered, the corresponding mean daily H range at Kew exceeded the average from all days by only 3 per cent. Most magnetic storms last only one or two days, few so much as four days; but a large sunspot is seldom so short-lived as this. The natural inference is that if the sunspot is the immediate cause of the magnetic storm, its effectiveness must be largely restricted to one particular stage of its development, or else to a very limited range of position relative to the earth. The investigation above referred to suggested an enhanced diurnal range in H for some days subsequent to the attainment of a maximum sunspot area on the sun, the largest range appearing 4 days subsequent to the maximum area.

The phenomenon most suggestive of an influence associated with specific small solar areas is the 27-day interval in the sequence of magnetic storms. The interval seems well established, and its most natural explanation, as suggested by Mr. Walter Maunder, is the existence for a number of solar revolutions of a comparatively narrow cone of radiation which sets up a magnetic storm whenever it crosses the earth. A difficulty is that the 27-day interval seems as well established for quiet as for disturbed conditions. A curious phenomenon, some cases of which were recently discussed by Father Cortie,<sup>4</sup> is that after a number of recurrences of disturbed conditions at 27-day intervals, quiet conditions intervened, to be succeeded by further sequences of disturbed conditions. On the other hand,

when we proceed by 27-day steps from a selected quiet day, we sometimes hit on a highly disturbed day. These phenomena suggest the possibility that a limited solar area may emit a radiation, which at one stage enhances and at another stage diminishes the ionisation of the upper atmosphere. If the radiation consisted at one stage of free ions, and at another stage of ejected matter which loaded up the ions naturally present in the upper atmosphere, the 27-day interval in quiet conditions would be intelligible. This suggestion was made originally in a frivolous spirit, but it may be more worthy of consideration than was originally supposed.

The possibility of a sunspot influence in atmospheric electricity seems to have occurred independently to several people, including the present writer.<sup>5</sup> It has recently been the subject of two papers by Dr. L. A. Bauer.<sup>6</sup> In the first of these, which dealt with the potential gradients recorded at the Ebro Observatory, Tortosa, he concluded that mean yearly values of potential gradient (P) and its diurnal range both increased with sunspot frequency. As a check, the writer<sup>7</sup> applied Wolf's formula to five sets of Kew potential gradient data, from two periods 1898 to 1909, and 1910 (or 1911) to 1920 (or 1921). The results were so far favourable to Dr. Bauer's conclusions in that a positive value of  $b$  resulted in four cases. But the fifth case gave a negative value, and the values of  $100b/a$  were all small, the four positive values averaging only  $+0.17$ , and the corresponding values of  $r$  averaging 0.49.

In his second paper (*l.c.* p. 186) Dr. Bauer expresses somewhat modified views, including

(a) "The probability is high that . . . potential gradient and its diurnal and annual ranges . . . are subject to sunspot influence."

(c) "During 5 of the past 7 sunspot cycles the potential gradient and ranges . . . generally increased with increasing sun-spottedness. For the remaining 2 sunspot cycles, the potential gradient . . . apparently decreased with increasing sunspot activity."

The epochs in which the relation is supposed to have been negative seem to be 1845-1855 (station Brussels) and 1886-1897 (stations Perpignan, Lyons, and Greenwich).

Some knowledge of the observational uncertainties is a desirable prelude to a consideration of the results. Suppose we take a water-dropper, the most efficient type of "collector." When the electrograph is working, the tube discharging the jet is connected to the needle of a quadrant electrometer. One pair of quadrants is maintained at a constant potential  $+v$ , and the other pair at  $-v$ , the sensitiveness varying with  $v$ . Suppose we break the connexion to the jet, and connect the needle to a variable source of potential. Raising the potential step by step, put marks on the paper on the recording drum answering to the voltages 100, 200, etc. Now remove the source of potential, and connect the needle to the discharge tube. For simplicity, suppose the air surrounding the jet to remain for some time at  $+100$  volts. On turning the jet on, the electrometer reading gradually rises, reaching a stationary

<sup>5</sup> Phil. Trans., A, vol 206, p. 303.

<sup>6</sup> *Terrestrial Magnetism*, vol 27, p. 1; vol. 29, pp. 23 and 161.

<sup>7</sup> Proc. Physical Society, vol. 35, p. 129.

<sup>4</sup> Proc. Roy. Soc., vol. 106, p. 19.

position in, say, 30 seconds. But the reading answering to the stationary position will be sensibly less than 100 volts, unless the insulation of the water tank and discharge tube is really good, and the deficiency is greater the poorer the insulation and the less efficient the collector.

Again, the potential at the site of the collector is usually a good deal lower than it would be at the same height above level ground remote from buildings. Thus, however good the insulation, the readings require multiplication by a factor to give true potential gradients, and unless the position of the collector and its environment (and the insulation of the water-dropper) are invariable, the factor varies with time.

The necessity for a reduction factor was generally unrecognised until comparatively recently, while changes calling for alteration in the factor are practically certain to have occurred in the older installations. Insulation is very hard to maintain good, especially with the older types of insulators. It generally suffers from damp weather, and some years are much damper than others. The outcome is that unless a reduction factor is regularly determined and applied, the absolute potential gradient and its diurnal and annual ranges, as deduced from the curves, may fluctuate as insulation is better or worse. They will also naturally alter with the growth of trees or shrubs, or modification of buildings near the collector.

Kew has probably a longer record from a fairly modern electrograph than any other observatory, and Dr. Bauer has suggested the utilisation of the earlier records. The curves prior to 1898 were unfortunately not tabulated, with the exception of one or two years, and the heavy labour required to do so now has not appeared justifiable in the absence of determinations of a reduction factor before that date.

To gauge the probability of Dr. Bauer's conclusions, his notation and methods must be understood. He employs two formulæ:

$$P - P_m = s'(S - S_m) \quad (A),$$

$$\text{and} \quad P - P_m = s(S - S_m) + t(T - T_m) \quad (B).$$

Here  $S$  represents Wolf's sunspot frequency,  $P$  the absolute value or the range of potential gradient,  $T$  the year, and the suffix  $m$  denotes the mean for the period considered.  $s'$ ,  $s$ , and  $t$  are constants determined by least squares. (A) is simply a variant of Wolf's formula, with  $s'$  written for  $b$ . (B) differs through the addition of a term varying linearly with the time. The correlation coefficient is called  $r'$ , in the case of (A) and  $r_s$  in the case of (B). Dr. Bauer attaches most weight to (B), but gives no adequate justification for its use. The question is important because  $r_s$  is usually larger than  $r'$ , so if (B) is admissible the case for a sunspot influence appears stronger than it otherwise would. Cases are conceivable in which (B) would be justified, e.g. if besides an 11-year period there were a much longer period, say 100 years, or if some gradual change had been in progress in the apparatus or its environment, which might reasonably be supposed a linear function of the time. But some positive justification seems called for in each specific case. The fact that the  $t$ -term usually improves the agreement with observation is no sufficient argument in its favour,

because, with two constants at our disposal instead of one, that is only to be expected. When  $t$  is small,  $s$  and  $s'$  differ but little, but when it is large, they usually differ considerably in size and sometimes even in sign. Large values of  $t$  appear more especially in the older series of observations used by Dr. Bauer, especially those for St. Louis, Perpignan, Brussels, and Greenwich. But they also occur in the case of some of the more recent data, including some from Kew. In 4 out of 7 cases at this station in Dr. Bauer's Table 5, p. 169, *l.c.*,  $s$  is positive, while  $s'$  is negative. In fact, the adoption of the two-term formula converts a vote against to a vote for a positive correlation.

One most important modern station, the uncorrected data from which might have called for a  $t$ -term, is dismissed by Dr. Bauer in the following words (*l.c.* p. 24): "Unfortunately as regards the Potsdam observations, various changes . . . especially during the period 1914-19 when no control observations . . . could be made, have introduced discontinuities . . . so as to make unsafe the utilization of the observations." This view has recently been controverted by Dr. Kahler, of Potsdam,<sup>8</sup> who claims that the mean annual values of potential gradient now published are satisfactory. Dr. Kahler adds that they do not support a sunspot influence, but he gives no figures. As the Potsdam series is longer than most, and the station has a high reputation for staff and equipment, it has seemed desirable to apply a Wolf's formula to the mean yearly values given by Dr. Kahler, treating them on parallel lines with data from Kew and Eskdalemuir. The results from the three stations are as follows, the unit for  $a$  and  $b$  being 1 volt per metre:

Quantity.	Period.	Station	$a$ .	$b$ .	100 $b/a$	$r$ .
Mean annual value	1904-23	Kew	309	+0.303	+0.098	0.37
" " "	" "	Potsdam	211	-0.216	-0.102	0.34
" " "	1911-21	Kew	312	+0.444	+0.142	0.56
" " "	" "	Potsdam	205	-0.143	-0.069	0.46
" " "	" "	Eskdalemuir	236	+0.440	+0.186	0.83
" " "	1911-21	Kew	152	-0.114	-0.075	0.23
" " "	1912-21	Eskdalemuir	110	+0.115	+0.105	0.25

The year 1911 was omitted in the final case at Eskdalemuir owing to some special uncertainties.

One of the outstanding things was the opposition between the Kew and Potsdam data from 1911 to 1921. At Kew the departures of  $S$  and  $P$  from their mean values agreed in sign in 9 of the 11 years, while at Potsdam they differed in 10.

Referring to Dr. Bauer's own tables of results, there seem to be only three of his stations—Tortosa and Eskdalemuir with at most 14 years' observations, and Kremsmunster with only 8—which supply in all the cases considered positive values for  $s$  and  $s'$ , and several of these values are quite small.

The data from Kew and Potsdam are suggestive either of no direct sunspot influence, or of a comparatively trifling influence liable to be masked by weather effects. Less conflicting results may be obtainable from regions having a less variable climate, but lower latitudes have been as yet very poorly represented.

A sunspot influence acting in different directions at

<sup>8</sup> *Ergeb. der met Beob in Potsdam in den Jahren 1921, 1922, und 1923*, p. VIII.

different places at the same time, and affecting the results at one station in opposite directions at different epochs, is something quite unlike the sunspot influence recognised in the diurnal variation of terrestrial magnetism. Its acceptance does not seem justified without much more observational support than it has yet received.

Some remarks in § 47 of Dr. Bauer's second paper (*l.c.* p. 184), if they stood alone, or even if they followed the conclusions on p. 186, might be interpreted as not

inconsistent with the conclusions reached here. If, however, he really regards the existence of a sunspot influence in atmospheric electricity as quite an open question, a more explicit statement is desirable, as several recent references to his work assume a relation to have been established.

*Note added June 3.*—Since the above was in print, a further paper by Dr. Bauer has appeared in the March number of *Terrestrial Magnetism*, in which he dissents from Dr. Kahler's conclusions.

### An International Campaign against Sleeping Sickness.

AMONG the limited number of post-War changes that it is possible to regard with satisfaction, not the least is an enhanced sense on the part of representatives of European nations of their responsibilities towards what are known as native races. Conspicuous manifestations of this new spirit have been shown by the British Government, and recent action on the part of the League of Nations is evidence of similar breadth of view. In 1922 the Provisional Health Committee of the League appointed a Committee of Experts, under the chairmanship of Dr. Andrew Balfour, for the purpose of collecting information as regards sleeping sickness and tuberculosis in equatorial Africa, and making certain recommendations with reference to these diseases. The members of the Experts Committee, in addition to the chairman, are Dr. E. van Campenhout, Director of the Public Health Service at the Belgian Ministry of the Colonies; Prof. Gustave Martin, formerly head of the French Sleeping Sickness Mission in French Equatorial Africa; and Dr. A. G. Bagshawe, Director of the Tropical Diseases Bureau, London. This Committee, which met for the first time in November 1922, submitted to the Health Committee of the League two most valuable Reports; and the outcome of the recommendations included in the second of these was an International Conference on Sleeping Sickness, which assembled last month in London, and was presided over by Mr. W. Ormsby-Gore, Under-Secretary of State for the Colonies. All of the countries interested in tropical Africa, namely, Belgium, France, Great Britain, Italy, Portugal, and Spain, were represented at the Conference by well-known authorities on tropical disease.

As most people are already aware, thanks to the prominence given to the matter by the daily press, among the recommendations that the delegates to the Conference have unanimously decided to make to the Council of the League of Nations, and to their respective Governments, is the formation of a small international commission for the investigation of sleeping sickness problems in Africa itself. It is suggested that this Commission shall consist of a few specialists in tropical disease furnished by the Powers interested in Africa, with the addition of a biochemist and an entomologist with local knowledge; and that it shall also include the well-known authority Dr. K. Kleine, the value of whose recent researches in Northern Rhodesia and elsewhere on the therapeutic effect of "Bayer 205" is widely recognised.

Since Uganda and the regions adjacent to Lake Victoria furnish the most suitable field for the study of the problems selected, it is proposed to make Entebbe

the headquarters of the Commission, and to place the latter under the presidentship and control of Dr. H. Lyndhurst Duke. The necessary expenditure, to which the respective Governments, the Health Organisation of the League of Nations, and scientific research institutions of certain countries, are to be invited to contribute, is estimated at some 10,000*l.* It is suggested that the Commission shall assemble at Entebbe at the end of next December, or in January 1926, and that it shall work for twelve months, after which it will submit a special report to the League of Nations Experts Committee. Guided by Dr. Duke, the Commission will apply itself in the first instance to a study of "the research methods and laboratory technique at the Entebbe Institute and its field laboratories, as well as the field work and measures taken against sleeping sickness in the Protectorate of Uganda and the infected districts of Tanganyika."

After inspecting the methods and highly promising results of Mr. C. F. M. Swynnerton's experiment in the control of *nagana*-carrying tsetse-flies at Shinyanga, Tanganyika Territory, the Commission will settle down to "joint laboratory investigations as to the methods of work which are most suited for research into the several problems referred to it" by the Conference. It is understood that these problems include, among others: the question of the existence, nature, and determining factors of any human immunity to trypanosomiasis; the comparative value from various aspects of trypanocidal agents; the function of wild and domestic animals as breeding grounds for the virus; and the possibility of *Trypanosoma gambiense*, the causal agent in trypanosomiasis as conveyed by *Glossina palpalis*, assuming the form known as *Trypanosoma rhodesiense*, and so becoming capable of dissemination by *Glossina morsitans*.

In addition to its proposals for the Commission, the International Conference has also advised the adoption of a number of highly important administrative measures, including arrangements for periodic official conferences, and frequent interchange of information between administrative and medical officers on both sides of boundaries between infected countries; the devising of means for giving legal effect to recommendations of the medical service engaged in the campaign against sleeping sickness; and methods for the control and reduction of trans-frontier native traffic in infected areas.

It must not be thought that, at the present time, before the proposed International Commission is yet in being, little or nothing is being done by the governments and medical services concerned to combat

sleeping sickness. Sleeping sickness and *nagana*, the kindred disease of domestic stock, are scourges which in greater or less degree, according to the physical and other conditions of localities, affect or threaten all countries and peoples in tropical Africa wherever the insect carriers of trypanosomes, the various species of *Glossina* or tsetse-flies, exist: that is to say, within roughly parallel lines drawn from the Senegal River to Somaliland, and from the southern boundary of Angola to Zululand in the south-east. In Africa to-day the tsetse-fly problem, with its contingent maladies, is more important than any other, and, in addition to its direct effect upon human life, is more than anything else retarding progress and development. Thus all European nations with a stake in the African continent, all those represented at the recent Conference, are vitally affected, and all are keenly alive to their danger.

Fortunately, with regard to sleeping sickness in general, there is no need to sound an alarmist note. Although in the Mongalla and Bahr-el-Ghazal Provinces of the Anglo-Egyptian Sudan, into which the disease has recently been introduced from French Congo, Belgian Congo and Uganda, the position is one of some anxiety; and though elsewhere, as in parts of Cameroons, French Equatorial Africa and Belgian Congo, there are foci of varying intensity, in no country nowadays is there anything comparable to the great epidemic of sleeping sickness that started on the northern shore of Lake Victoria in 1901. In the course of this outbreak the population of the districts affected, originally about 300,000, was reduced by two-thirds in six years. The energetic methods taken to combat the disease, including wholesale removals of natives, closing of areas, and clearing of lake and river margins, are too well known to need recapitulation. Their success is shown by the results detailed by Dr. G. D. Hale Carpenter, Senior Medical Officer in charge of Sleeping Sickness, Uganda, in his Report for 1920-21. In the course of a tour of inspection covering some 1750 miles, Dr. Carpenter examined no fewer than 54,600 natives, among whom he found only 264 cases of sleeping sickness.

Since the Uganda outbreak, the campaign has been waged energetically, often with a large measure of local success, not in British dependencies alone, but also in those of almost all other countries as well. It is impossible to read the Reports of the Committee of Experts, to which reference has already been made, without being filled with admiration for the work

carried out by the medical services and administrations concerned. In the matter of sleeping sickness, as it affects the native populations of Africa, "the white man's burden" has been shouldered with goodwill. In French Equatorial Africa the labours of the medical services, often sadly handicapped by insufficiency of personnel and equipment, and in the face of difficulties which only those familiar with the conditions of tropical African travel can fully appreciate, have been directed especially towards the systematic *atoxylisation* of the sick. This line of policy not only effects a proportion of cures in the early stage of the disease, but also—what is even more important—by removing the trypanosomes from the peripheral blood, prevents persons already infected from endangering their neighbours by way of the local tsetse. By means of this system excellent results have already been obtained, and in some instances great epidemic foci appear to have been stamped out; the method has already been introduced into Uganda by Dr. Carpenter. In the case of African natives, however, it is often difficult to ensure that no sick person contrives to escape examination by a medical officer on tour; and in this connexion it may be noted that the appointment, in threatened districts, of special administrative officers to deal only with sleeping sickness affairs, as is already the practice in the Lake Victoria area of Uganda, was urged emphatically by Dr. Carpenter in 1923.

Without entering further into the technicalities of the campaign against sleeping sickness as at present conducted, or dwelling upon well-known methods for the local abolition of *Glossina palpalis*—the most formidable but by no means the only tsetse-fly carrier of the disease—it is hoped that enough has been said to indicate some at least of the conditions as they now exist, before the appointment of the International Commission. At the recent meeting of the second Imperial Entomological Conference, at which the tsetse-fly problem was discussed, Dr. Andrew Balfour referred in optimistic terms to the beneficial results likely to accrue from "the association for a considerable time of two such brains as those of Dr. Kleine and Dr. Lyndhurst Duke." On the same occasion it was pointed out by Mr. Ormsby-Gore that the Commission is bound to have great educative value, not only on public opinion in Europe, but also on local administrations in Africa. We heartily wish it success.

E. E. A.

### Current Topics and Events.

IN February 1825, Faraday was appointed director of the laboratory of the Royal Institution, and his first act after appointment was to invite the members to evening meetings in the laboratory. These evening meetings developed into the Faraday evening discourses which have remained a feature of the Institution unto this day. It was accordingly very appropriate that the celebration of the centenary of the discovery of benzene by Faraday should be inaugurated on June 12 by the Friday evening discourse on "Faraday as a Chemist" by Sir William Pope. Elsewhere in this issue we print Sir William Pope's discourse together with papers read on the occasion of the centenary celebrations on June 16. Sir

William Pope first referred to Faraday's youth and early scientific training and then passed on to a brief discussion of his chemical investigations. Faraday analysed caustic lime from Tuscany, repeated and extended E. D. Clarke's work on the oxy-hydrogen blowpipe, and he burnt diamonds. He discovered the substances now known as hexachloroethane, tetrachloro-ethylene, and hexachlorobenzene before he isolated benzene in 1825. Steel alloys and optical glass were studied for several years and a large number of gases were liquefied for the first time. He determined the composition of naphthalene and investigated the action of chlorine on benzene in sunlight, in this way discovering *p*-dichlorobenzene.

Gold films, solutions of colloidal gold and electrochemical researches nearly complete the list of his chemical investigations. Sir William Pope laid stress on the significance of the discovery of benzene in view of later important technical and scientific developments, and he referred to the marvellous suggestiveness of much of Faraday's work. He also described Faraday's pre-eminence as an experimenter, his greatness as a scientific theorist, his versatility, and his innate but undeveloped mathematical ability. The fruit of Faraday's labour has not yet all been gathered; a hundred years hence the Friday evening lecturer will have an even more wonderful tale to tell of discoveries inspired by the work and thought of Michael Faraday.

A SMALL but interesting exhibition has been arranged and is now on view at the Science Museum, South Kensington, commemorating the centenary of the discovery of benzene by Faraday. Amongst the exhibits shown at the Science Museum are two original specimens of benzene, prepared and labelled by Faraday, which were bequeathed to the Museum in 1911 by Mr. H. L. Barnard—it will be remembered that Faraday married Sarah Barnard—and an autographed photograph of himself which was bequeathed to the Museum by Miss Jane Barnard. The original cabinet in which Faraday stored the specimens of benzene and which contains many other specimens of his chemical discoveries, including the polished weldings of steel and platinum and the alloys produced with Mr. Stodart in 1821 in the search for a non-rusting steel, is also on view. Other interesting exhibits show the importance of benzene to the synthetic dye industry and illustrate the distillation of coal-tar, from which benzene is obtained on a commercial scale. A series of models of the principal space formulæ proposed for benzene, showing the relative space arrangements of the atoms within the molecule, is not only instructive but emphasises the importance with which benzene has been regarded since the time of its discovery.

THE trial in the United States of Mr. Scopes, for teaching evolution in a State-supported Tennessee school, promises to become a *cause célèbre*. It is attracting widespread attention, and a bewildering array of legal authorities has been enlisted on both sides. The defence is being financed by the American Civil Liberties Union, which has secured the help of many distinguished barristers, including Mr. Bainbridge Colby, a former Secretary of State in Wilson's cabinet. He will be supported by numerous advisers representing the Modernists, the champions of free speech, and scientific experts. Mr. W. J. Bryan will take part as one of the counsel for the prosecution. The Tennessee Text Book Commission has introduced a new text book of biology for use in the State schools, which states, in reference to animals resembling man, that "none of them are to be thought of as a source or origin of the human species." Take no thought of the past as well as of the morrow seems to be the desire of the Fundamentalists as to the history of man.

THE leading article in NATURE of June 6 on "An Imperial Research Committee" contained reference

to the possible effect of the salt-tax in India on the efficiency of the native population, the suggestion being that the taxation of this vital commodity had the effect of reducing its consumption. Dr. F. Martland Gibson, lately director of the King Institute of Preventive Medicine in Madras, in a letter to the editor dated June 13, takes exception to this statement. During his twenty years' residence in India the salt-tax was never higher than one halfpenny per pound. The daily physiological requirement of salt per head of the population addicted to a vegetarian diet has been estimated at 30 grains. On that basis, the effect of the tax on the consumption of salt should be negligible. Even if the consumption of salt far exceeded physiological requirements the effect of the tax would scarcely be felt even by the poverty-stricken Indian, and should be a smaller factor in reducing consumption than the manipulation of prices by salt dealers. Dr. Gibson would probably agree, however, that political and psychological factors must also be taken into account in connexion with this tax. For political reasons—for example, non-co-operation—the Indian might refuse to buy any salt, while the fact that a certain commodity is taxed, to whatever amount, might also lead to greatly reduced consumption by peoples living continuously on the poverty-line. But whatever the effect of this particular tax, it can be argued that it is wrong in principle to tax vital commodities before other and more equitable means of raising revenue have been exhausted.

AN appeal has been issued from Government House, Nairobi, for subscriptions to the Coryndon Memorial Fund, with which it is proposed to improve and to extend the existing natural history museum in the Kenya capital. This is an object which should not only make its appeal to scientific workers on its intrinsic merits, but also because the late Sir Robert Coryndon was probably unique among British colonial governors in his appreciative understanding of the importance of scientific research and the educative value of carefully selected and properly cared for exhibits of naturalists. In spite of the pressing problems involved in the administration of the most difficult colony in British possession, he found time, in the year preceding his tragically sudden death, to make a comprehensive survey of the Victoria Nyanza territories and to furnish a stimulating and invaluable report to the Secretary of State for the Colonies, in which he stressed the importance of a unified research service for the Lake area. A few years before, while Governor of Uganda, he gave an impetus to medical and veterinary research, and to him can be attributed the growth of the scientific spirit in that Protectorate. Reference has been made already in NATURE to the appeal he made on November 20 last year to his fellow-countrymen for support for the Amani Institute. This formed part of a general plea for more generous encouragement of scientific research. The fact that on that occasion he specifically commended the enlargement and proper equipment of the Nairobi Natural History Museum to the attention of his

audience as a worthy object for support lends emphasis to the appropriateness of the projected tribute to his memory. His life was devoted to the service of the British Empire, and he had the highest conception of the function which science fulfils in its development.

In connexion with our note of last week on Dr. J. W. L. Glaisher's jubilee of fellowship of the Royal Society, it is of interest to recall a long-forgotten episode as to the assistance he gave fifty years ago towards the publication of Peter Gray's "Tables for the Formation of Logarithms and Anti-Logarithms to Twenty-four or any less Number of Places," an 8vo work issued in 1876. Gray states that he allowed some manuscripts of his to lie by for a number of years owing to printing difficulties. At length an abridgment of his papers was made and communicated to the *Assurance Magazine*. These papers were afterwards collected and published in 1865. This tract, after some years, came under the notice of Mr. T. Warner, F.R.A.S., of Brighton, who opened a correspondence with Gray, and finally offered a most handsome contribution towards the expenses of printing the whole set of tables. Having (he says) mentioned the circumstance to two gentlemen interested in such matters, they each offered quite spontaneously a liberal contribution in supplement of Warner's gift. The two who gave this gratifying proof of interest were Dr. J. W. L. Glaisher, F.R.S., and Mr. H. D. Hoskold, a mining and civil engineer of Dean Forest, Gloucestershire. Dr. Glaisher made a number of valuable suggestions in the course of printing.

LAWRENCE ROOKE, astronomer and mathematician, who died on June 27, 1662, was an active member of the group who were concerned in the promotion of experimental philosophy. He was chosen to succeed Samuel Foster in the professorship of astronomy at Gresham College in 1652, and in 1657, upon Dr. Whistler's resignation of the chair of geometry at the College, was permitted to exchange that of astronomy for it. Educated at Eton, he was for a while at Cambridge, but in 1650 he transferred himself to Wadham College, Oxford, with the view of studying under Dr. Wilkins, then Warden, and Dr. Seth Ward, the Savilian professor of astronomy. It will be recalled that it was after one of Wren's lectures at Gresham College, in 1660, that the company "withdrew for mutual conversation into Mr. Rooke's apartment," there to discuss a project for a new college or society for physico-mathematical learning. At a meeting of the Royal Society on June 13, 1661, Rooke was desired to bring in a relation of the satellites of Jupiter and the height of the atmosphere. Next month he read his paper of observations of the eclipses of the satellites of Jupiter, for which thanks were given him. On October 9, 1661, Rooke, with Croune and Dr. Pope, were appointed a committee to view propositions for inquiries in foreign parts.

Rooke's death, in his fortieth year, had a tragical aspect. The Marquis of Dorchester, who had a great

regard for him, was accustomed to entertain him at Highgate, bringing Rooke by coach on Wednesdays to the Royal Society's meetings at Gresham College. One day in the heat of early summer, Rooke walked into London (so we are told) and "took cold, which occasioned a fever, and that put an end to his life at his lodgings in Gresham College," on the very night, which he had for some years awaited, wherein to finish accurate observations of the satellites of Jupiter. So intent was he to the last upon completing his theory of that planet, wanting but one observation more (which might be made on the night of his death) to perfect that theory, he desired Dr. Pope to go to the Royal Society and request some person to do it. The Bishop of Exeter (Dr. Ward) intended to erect a monument to his memory, but instead of that gave the Royal Society, in memory of his friend, a large pendulum clock, by Fromantel, which was set up in the actual room at Gresham College where the circle of philosophers met; afterwards it was removed to the hall of the Society in Crane Court, Fleet Street.

AFTER an absence of four weeks, Captain Amundsen's aeroplanes returned to Spitsbergen on June 18, having reached lat.  $87^{\circ} 44' N$ , long.  $10^{\circ} 20' W$ , a distance of 136 miles from the Pole. Amundsen's preliminary account of the journey is published in the *Times*. The aeroplanes on leaving Spitsbergen encountered fog for a few hours, and when the weather cleared, were too far west. A more easterly course was laid, but it was decided to land in order to get definite bearings before continuing the flight, since at 1 A.M. on May 22, after eight hours' flying, half the petrol had been consumed. The only possible landing place was a water lane through the pack. Both planes were gripped in the ice, but eventually, after 24 days' work, one of them was released. It showed signs of strain but was undamaged. With a greatly reduced load it was possible to start this machine from a levelled stretch of ice on June 15. In  $8\frac{1}{2}$  hours, North Cape of Spitsbergen was reached, and there a passing sealer was met and carried the explorers to King's Bay. To the farthest point the planes flew 621 miles at an average speed of 93 miles per hour. Capt. Amundsen believes that but for a head wind causing leeway, he could have reached the Pole with the petrol he carried. The two 370 h.p. Rolls Royce Eagle IX engines of each aeroplane worked without a hitch. The geographical results of the expedition are practically confined to a sounding of 2051 fathoms at the place of descent. This confirms the conception, founded on Nansen's work, of a deep polar basin and dispels any probability of land on the European side of the Pole.

THE members of the Inter-State Post-Graduate Assembly of America visited Edinburgh on June 18-20. On June 18 the visitors assembled in the M'Ewan Hall, where an address of welcome was given by the Vice-Chancellor of the University, Sir Alfred Ewing, following which the honorary degree of LL.D. was conferred on Dr. Charles H. Mayo of

Rochester, Minnesota. During the three days clinics were arranged in the Royal Infirmary in the departments dealing with medicine, surgery, gynaecology, and the diseases of ear, nose, throat, and eye. There were also clinics in the Sick Children's Hospital and the Maternity Hospital. Demonstrations and exhibits were arranged by members of the staffs of the departments of surgery, midwifery, pathology, bacteriology, and tropical diseases of the University and of the laboratory of the Royal College of Physicians. An evening reception was given on June 18 by the Lord Provost, Magistrates and Council of the City at Inverleith House, kindly placed at their disposal by Prof. Wright Smith, Regius keeper of the Royal Botanic Garden, Edinburgh, and a visit was made to the historical apartments in Holyrood Palace on the afternoon of June 19.

THE Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik at Munich, described in our issue of April 25, p. 611, was opened on May 7 with every mark of national rejoicing. The Museum, as its name implies, is devoted to applied science, and has for its aim the spread of knowledge of the great discoveries and inventions upon which rest the material civilisation of to-day. The festivities commenced on Tuesday, May 5, with a procession of allegorical cars, representing the principal branches of science, through the decorated streets of the city. On the day following the business meeting took place and was attended by ministers, mayors of large cities, leading industrialists, representatives of the Verein deutscher Ingenieure, of the universities, and of some foreign countries; the representative from England was Mr. H. W. Dickinson of the Science Museum, South Kensington. On May 7 a symbolical play, specially written for the opening by Gerhart Hauptmann, Germany's leading living poet, was performed.

THE Museum building, commenced in 1906, is an imposing structure, to the designs of Gabriel and Emanuel von Seidl, situated on an island in the river Isar. In plan the building is roughly 100 m. square, and the whole ground floor is occupied by exhibition space, but in the three floors above, a well 60 m. square gives the necessary lighting. The floor space amounts to about 35,000 sq. metres. At one corner is a tower 64 m. high, and there are three domes devoted to astronomy. The exhibits have been chosen with good judgment. Very great use is made of interiors, and as examples we may mention a scythe forge of 1803 from the Black Forest, the alchemist's laboratory of the middle ages, and a paper-mill of 1708. With these may be classed realistic representations of stone, ore, coal, and salt mining situated below the floor level of the Museum. Nor must mention of the planetarium in the astronomy section be omitted. By projection apparatus images of the fixed stars, or of the sun, moon, and planets, are thrown on a domed ceiling, and their apparent motion over a long period is reviewed in a few minutes. The apparatus has created the keenest interest, and several similar instruments have been ordered; we should like to see such an apparatus set up in Great Britain. The

Museum is in no sense a State institution, but owes its existence mainly to the labours of Ing. Dr. Oskar von Miller, a well-known electrical engineer, now in his seventy-first year. It is a monument of what can be done by personality, scientific knowledge, ordered imagination, and organising ability, even when interrupted by the War, the subsequent revolution, and the inflation of the currency.

THE Department of Scientific and Industrial Research is carrying out a series of investigations into adhesives. Some of this work has direct industrial application; some of it is of the nature of purely scientific research, *e.g.* investigations into the chemistry of gelatin and the mechanism of adhesion. It is hoped that the more strictly scientific investigations will enlarge the present range of industrial application. It has now been suggested by a prominent firm in the industry that it should be brought into closer contact with the fundamental scientific work, and it is prepared to contribute towards the cost. The Department has accepted this suggestion and is prepared to make similar arrangements with other interested firms for this part of the work, and to furnish progress reports from the Committee in charge, on the understanding that they will on their part communicate any information of general interest they may obtain from their own investigations based upon the results of the Committee's researches. Particulars of the scheme can be obtained from the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1.

ONE of the main functions of the Fuel Research Board of the Department of Scientific and Industrial Research is a survey and classification of the coal seams in the various mining districts by means of physical and chemical tests in the laboratory, supplemented where desirable by large scale tests at H.M. Fuel Research Station, East Greenwich, or elsewhere. The Board has decided that the best way to carry out this work is by means of local committees representing the local colliery owners and managers, the local branch of the Institution of Mining Engineers, the Fuel Research Board, and the Geological Survey of Great Britain, as well as outside scientific interests. Each committee is charged with the duty of supervising the work of the physical and chemical survey in a coal mining area; and in this way the survey becomes of practical value from the commencement, since local knowledge and experience are made available, and the seams to be investigated and the general programme of work are decided by those who are able to estimate most correctly the relative importance of the problems to be solved. The seams selected undergo physical and chemical examination by local investigators appointed for the purpose, after which a final selection is made of those seams likely to justify experiments on a technical scale in order to test their suitability for particular uses or methods of treatment. Committees have for some time been actively at work in the Lancashire and Cheshire and in the South Yorkshire areas, and another committee has recently been appointed to deal

with the North Staffordshire area. The North Staffordshire Colliery Owners' Association and the North Staffordshire Institute of Mining Engineers are co-operating in the work.

THE British Museum (Natural History) is to be congratulated on the rapid progress which is being made with the issue of its series of picture postcards illustrating various aspects of natural history. The latest additions include two further series in colour of British birds (summer visitors), an additional two series, also in colour, of British flowering plants, a set of restorations of fossil reptiles, a group of British Crustacea, and a series illustrating colour change in flat fishes, the last three series in black and white. Of these, the most interesting, because perhaps the most original, are those of the fossil reptiles. They are reproduced from drawings made by Miss Alice B. Woodward, and are remarkably natural in their general effect, suggesting a much less virile and more decadent group of animals than the majority of restorations tend to convey. The cards are admirably and clearly reproduced, and maintain the high standard set by their predecessors.

THE Trustees of the British Museum have published a second edition of the valuable handbook to the ethnographical collections which has been out of print for some little time. Mr. T. A. Joyce is again responsible for the text—in this edition with the assistance of Mr. H. J. Braunholtz. Where necessary the text has been modified to bring it into agreement with the growth of anthropological knowledge since the first edition was published in 1910, and a certain amount of supplementary matter has been added. The most considerable addition, however, is in the illustrations. Eighteen text-figures have been added, making two hundred and ninety-three in all, and five plates, bringing the total number up to twenty. Of these illustrations the most interesting are those figuring additional examples of African art, and in particular may be mentioned the very fine ivory mask from Benin. Notwithstanding the increased cost of printing, the price of the handbook has been raised from two shillings to two and sixpence only. Even in the board covers which have taken the place of the cloth of the earlier edition, this is remarkable value.

THE report for 1924 of the Director of the National Botanic Garden at Kirstenbosch, South Africa, records a gallant struggle to continue the development of this wonderful garden site near Cape Town in the face of great financial difficulties. It is, however, regrettable to learn that during the year expenditure upon the Garden, already ridiculously small, had to be cut down owing to reduced revenue, the Government contribution to revenue remaining at the same figure as previously. The University of Cape Town has now established the Bolus Herbarium at Kirstenbosch on a site allotted by the Trustees of the Garden, so that facilities for scientific work on the spot are considerably improved. During the present year, with aid from the Government on the pound for pound principle, the Harold Pearson Memorial Hostel should

be completed, with accommodation for a lady warden and about ten residents and servants.

THE Kew Hand-Lists of Herbaceous Plants were issued in the first place to show what species are actually grown at Kew, and also to reduce, if possible, the nomenclature in use in gardens to something like a standard. Possibly on account, particularly, of this second aim, the Kew Hand-Lists have always been found of very general use, and the second edition of the Hand-List of Herbaceous Plants, issued in May 1902, has long been out of print. A new edition appeared in January of this year, but this appears as three lists, (1) Herbaceous Plants, (2) Rock Garden Plants, (3) Hardy Monocotyledons. A new edition of the Hand-List of Trees and Shrubs (excluding Coniferae) grown in Kew has also been prepared. This list has been revised in accordance with the International Rules of Nomenclature.

THE subject of climatic changes is arousing great interest in the United States at present, and is being attacked along several different lines. Palæo-climatology is a borderland science; it lies between meteorology, geology, botany, and zoology, and no specialist in only one of these subjects can be fully qualified to deal with all aspects of the problem. It is a case for team-work, and we accordingly welcome the publication, in the *Scientific Monthly* for May, of a series of papers read at the December meeting of the American Association for the Advancement of Science on the subject of "Ancient Climates." Meteorology is represented by Dr. W. J. Humphreys, who gives an account of the possible causes of climatic changes, and glacial climatology by Dr. E. Antevs, while S. S. Visser presents an account of Huntington's "Solar-cyclonic hypothesis." Prof. A. P. Coleman deals with the geological aspects of ice-ages, Dr. T. W. Stanton reports on the Mesozoic invertebrates, and Dr. David White discusses the plants of the Upper Palæozoic. The papers are sufficiently interesting taken by themselves, and are rendered more so by their juxtaposition, but the reader is not given any help in considering their bearing on each other. We should like the authors to have met round a table afterwards, and to have formed themselves into a committee with power to co-opt representatives of other sciences such as chemistry and astronomy. A joint report by such a committee would be of outstanding importance in the study of ancient climates.

THE Academy of Sciences of Russia will celebrate its bi-centenary at Leningrad and Moscow between September 6 and 14 next. Foreign representatives are being invited and will receive special hospitality.

A SPECIAL general meeting of the Royal Astronomical Society will be held in the rooms of the Society on Friday, July 24, at 4.30 P.M. It is hoped that a number of foreign astronomers who will be in England in connexion with the meeting of the International Astronomical Union will be present and will speak about their work.

MR. L. S. AMERY, Secretary of State for the Colonies, has consented to receive at the Colonial Office, on

July 7, a deputation which will discuss with him the question of the further development of the work of the Imperial College of Tropical Agriculture for the whole Empire. The deputation, which will be introduced by Lord Burnham, will be of a thoroughly representative character.

WE much regret to announce the deaths of Mr. W. J. Dibdin, formerly chief of the Chemical and Gas Department, London County Council, and a leading authority upon the subject of purification of sewage by micro-organisms in contact and slate beds, on June 9, aged seventy-four years, and of Mr. D. B. Dowling, geologist on the Canadian Geological Survey since 1891, who was known for his work on the formation of coal, aged sixty-six years.

ACCORDING to the Singapore correspondent of the *Times*, the Council of the King Edward the Seventh College of Medicine has announced that the Rockefeller Foundation has presented to the college 350,000 dollars for the endowment of chairs of bacteriology and biochemistry, on condition that the Government founds an extra chair of biology and agrees to equip and maintain the three departments.

THE seventy-eighth annual meeting of the Palæontographical Society was held at Burlington House, London, on June 19, Mr. E. T. Newton, president, in the chair. In the annual report of the council, regret is expressed at the decreasing support received from English public libraries and local societies, but the renewal of subscriptions from the countries of central Europe and new subscribers from the United States of America are noted. New monographs of the Upper Eocene Flora and of Dendroid Graptolites were announced. Prof. H. L. Hawkins and Messrs L. R. Cox, A. W. Oke, and G. W. Young were elected new members of council. Mr. E. T. Newton was re-elected president, Mr. Robert S. Herries was re-elected treasurer, and Sir A. Smith Woodward was re-elected secretary.

LORD BALFOUR is to deliver the presidential address at the statutory meeting of the recently formed Institute of Philosophical Studies, to be held at the Royal Society of Arts on June 29 at 4.30. The Institute has the patronage of an imposing array of names. The objects are excellent but very indefinite as set forth in the only prospectus we have received. If the aim of philosophy is "to see life steadily and to see it whole," and if the directors in furthering this aim propose "to disentangle our beliefs from a confused jumble, and to purify them of a great many irrelevancies," it would be useful if they would give some definite idea of their mode of procedure. The Institute does not propose to compete with the universities, though it will arrange lectures in all branches of philosophy and encourage research in any of its departments.

BULLETIN No. 12 (1924) of the New South Wales Department of Mines deals with coke and the by-products arising from its manufacture. The text contains numerous statistics and is well illustrated by photographs. After a brief historical introduction,

the various coals and types of ovens are described, followed by detailed descriptions of the coking process as carried out in various Australian works.

WE have received a copy of Circular No. 12 of the Engineering Experiment Station of the University of Illinois, entitled "The Analysis of Fuel Gas." The pamphlet gives a description of the apparatus developed at the University of Illinois for the purpose of analysing fuel gas, and contains a synopsis of the methods best adapted to this type of apparatus. These methods are in the order of procedure necessary for carrying out the analysis. A comprehensive review of methods to be used with other types of apparatus is included in the appendix of the circular, which may be obtained from the Engineering Experiment Station, Urbana, Illinois.

THE April catalogue of Mr. C. Baker, of 244 High Holborn, London, W.C. 1, contains full descriptions of more than 2500 pieces of second-hand scientific apparatus. The photographic section, which was included in recent catalogues, has been omitted, and is to be published as a separate pamphlet in accordance with the pre-War custom. The present catalogue is noteworthy on account of the wide selection of astronomical instruments offered for sale. These include reflecting and refracting telescopes, mounted both equatorially and in the altazimuth manner, transit and meridian instruments, object glasses and eyepieces, mirrors and flats, stands and mountings, sidereal clocks, etc. The number of instruments of each type is exceptionally large, the equatorial refractors, for example, numbering twelve, and ranging in aperture from 3-in. to 8-in., and in price from 35*l.* to 595*l.* A 7-in. Cooke photo-visual refractor with accessories is included. All the instruments advertised are guaranteed to be in adjustment.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A part-time assistant-lecturer (woman) in hygiene (infant welfare work and personal hygiene) and demonstrator in bacteriology at King's College for Women (Household and Social Science Department), Campden Hill Road, W.8—The Secretary (June 30). Two assistant lecturers (one with special qualifications in science) in the department of education of the University College of the South-west of England, Exeter—The Registrar (July 2). A second assistant in zoology in the University of Aberdeen—The Secretary (July 8). An assistant in pathology in the University of Aberdeen—The Secretary (July 8). An assistant in the Nautical Almanac Office—The Secretary, Civil Service Commission, Burlington Gardens, W.1 (July 9). A demonstrator in chemistry in the University of Aberdeen—The Secretary (August 8). A lecturer in education in the University of Manchester—The Internal Registrar. An assistant in the department of geology of the Queen's University of Belfast—The Secretary. A lecturer in biology with special qualifications in zoology, and a lecturer in chemistry, at the Portsmouth Municipal College—The Secretary, Offices for Higher Education, Municipal College, Portsmouth.

## Research Items.

**THE SAN BLAS INDIANS.**—Recent references to the San Blas Indians of Panama in connexion with the occurrence of "White Indians" in Darien, and their uprising against the control of the Panama Government a month or two ago, give a topical interest to an article on these tribes by Mr. A. F. Loomis in *Scribner's Magazine* for June. They now number about 30,000. Those who live on the coast are skilled sailors, their canoes, logs hollowed by elementary tools without keel or deck, going out to sea when the weather is too rough even for coasting-schooners. Little is known of them; no one not of their race is allowed to remain within their territory at night. The women wear gold nose-rings, but the most characteristic feature of their dress is an upper garment of appliqué work which is made of pieces of coloured material sewn on to a cloth foundation in most intricate and highly conventionalised patterns. Large flat discs of beaten gold are worn pendent from the ears. Armlets and anklets of beads are wrapped so tight as to stunt the extremities. The marriage ceremony consists in carrying the groom to the girl's house and placing him in her hammock, whence he flies for two nights in succession. On the third night he lifts her veil and sees her face for the first time. The next morning he leaves his father's house, and the eating of the meal the bride has prepared concludes the marriage rite. The son-in-law resides with the bride's father and virtually becomes his servant.

**EXCAVATIONS AT MARGIDUNUM.**—In describing pottery from a well of Claudian age at Margidunum (Notts) in the *Journal of the Society for the Promotion of Roman Studies*, vol. 13, pts. 1-2, Dr. Felix Oswald gives a brief account of the general results of his excavations, which have extended over several years. This camp formed a link in the chain of frontier posts established between Severn and Trent in A.D. 47. Previously it was unknown except by name. The site covers about 8 acres. The mud surface due to marshy ground was cleared away by the Romans and about six inches of river sand substituted. Drainage ditches flowing into the first of five outer ditches have furnished some of the earliest evidences of Claudian occupation in the pottery, which often shows La Tène features, Claudian sigillata ware, a coin of A.D. 41, and a tinned bow brooch almost identical with a tinned fibula from Ham Hill, Dorset, which has been dated A.D. 40-50. The persistence of La Tène features in the pottery suggests that local native industries were not suppressed but rather that there was an increased demand. Under Nero and Vespasian iron was smelted in rectangular pits with side gulleys exactly as in Africa to-day. The fort was twice destroyed by fire, possibly by Boudicca and by the Brigantes, and was abandoned before the end of the first century.

**A NEW BRITISH LAND PLANARIAN.**—Mr. E. Percival records (*Quart. Journ. Micr. Science*, March 1925) the finding of a new British land planarian—*Rhynchodemus britannicus*. He collected specimens in Yorkshire under large stones and logs which had lain undisturbed for a considerable time, always on moist clay or loam, and associated with earthworms and slugs, never with centipedes and carnivorous beetles. The planarian, which is extremely contractile, may attain a length of 90 mm., and is 1.5 mm. broad when in the extended condition. The anterior end tapers gently to a fine point, and just behind the tip is a single pair of minute eyes. The colour is variable—sulphur-yellow, salmon-pink, or dirty grey, and the ventral surface is paler, the mid-ventral

region being practically white. The mouth is mid-ventral and about the middle of the length of the worm, and the genital pore 5-8 mm. farther back. Mr. Percival gives a brief account of the anatomy, which is similar to that of other species of *Rhynchodemus*. The cocoons are 2 to 3 mm. in diameter. The planarian feeds on earthworms, sucking up the partly decomposed tissues of the worm and leaving only the cuticle, but how the worms were killed could not be ascertained. In one specimen many spores of a gregarine, probably *Monocystis*, were present in the endoderm cells, no doubt ingested while feeding on an earthworm. Two examples of this new species have also been collected at Stockport, and the author thinks that a specimen found at Plymouth probably also belonged to this species, in which case this new planarian would appear to be widely distributed in England.

**THE DEVELOPMENT OF EGG FRAGMENTS.**—Prof. C. V. Taylor and Prof. D. H. Tennent give a preliminary report (Carnegie Institution of Washington, Year Book 23) on the development of fragments of the egg of the sea urchin *Lytechinus (Toxopneustes) variegatus*, which they studied in the Tortugas Laboratory. The methods of micro-dissection were employed, *i.e.* the eggs were cut with very fine glass needles manipulated in a moist chamber on the stage of the microscope under fairly high magnification. A preliminary experiment was carried out to ascertain whether the operative technique would cause the parthenogenetic development of the egg; 50 eggs were pricked with the tip of the micro-needle but none developed. Eggs were transected in the vertical or the horizontal plane into two halves, one nucleated and the other not. When these halves, transferred to watch glasses, had rounded off, sperms were added, and by careful treatment many fragments both nucleated and non-nucleated were reared to the pluteus stage. 122 pairs of such fragments were studied. Cleavage followed insemination in 74 of the nucleated fragments and in 66 non-nucleated portions. The cleavage of both fragments is not, as stated by Delage, identical and as in the normal egg—one of the fragments follows the normal mode, but in the other the cleavage which should have given rise to the micromeres was an equal division of the cells of the vegetative half, and this division occurred shortly after the equal division of the four cells of the animal half of the fragment.

**BIRDS AND BUTTERFLIES OF EAST AFRICA.**—The *Journal of the East Africa and Uganda Natural History Society* takes a high place among publications devoted to the description and bionomics of local fauna. A recent issue (No. 21, March), under the editorship of Dr. V. G. L. van Someren, contains the opening parts of two excellent faunistic papers, dealing respectively with the birds and butterflies of Kenya and Uganda. The former of these papers, which is the work of the editor, gives a good account of the Guinea-fowls of the region, and is illustrated by a plate representing seven of the species, together with a diagram explaining the nomenclature of the external parts of a bird, and a chart showing the elevations from the lake level to the coast at Mombasa, with the various avifaunal areas. Careful descriptions are given of the adult and the successive immature stages of the plumage in each species, and valuable notes are appended on the distribution, courtship, nesting, and feeding habits of this characteristically African group of game-birds. The following paper, on the butterflies of the same region, is the joint work of Canon K. St. A. Rogers and Dr. van Someren. The

species dealt with are those of the genera *Danaiida* and *Amauris*. An admirable series of photographs accompanies the paper, in which are depicted numerous examples of the eggs, larvæ, and perfect insects of many of the forms described. As in all the work of Canon Rogers, great attention is paid to points of bionomic interest, and we may be permitted to trace in his careful notes on distribution, mode of flight, relative distastefulness, mimicry, etc., the influence of the Hope Department at Oxford, the studies pursued in which place owe so much to the activity and perseverance of Canon Rogers as a collector. It is to be hoped that these contributions to the natural history of East Africa, so well begun, may be pressed to an equally valuable conclusion.

**VIRUS DISEASES OF THE HOP.**—E. S. Salmon and W. M. Ware briefly describe two virus diseases of the hop, "nettle head" and mosaic, in the *Gardener's Chronicle* for May 9. In connexion with the interesting work they are doing at Wye in raising new strains of hop of commercial promise, the authors had occasion to send out a new seedling for trial in the hop-gardens. This seedling, while itself apparently resistant to mosaic, has thus come under suspicion as a carrier of mosaic to the susceptible varieties around it, thus recalling Bewley's experience with tomato plants and the similar suggestion made by Atanasoff (*Phytopathology*, March 1925) that the potato varieties Ashleaf and Koksiaan (equivalent to Jersey Non Such), themselves very resistant to stipple-streak, may transmit it to varieties, which are then swept away by its ravages. Only experiment can settle such questions, and as virus diseases are most certainly transmitted by grafting, Salmon and Ware describe successful methods for grafting hops.

**RHODODENDRONS FROM KWEICHOW, CHINA.**—Twelve more flowering plants are figured in the plates in Part III. of Volume 150 of *Curtis's Botanical Magazine*; they range from an old-established horticultural favourite like *Begonia manicata* Linn., introduced from Mexico before 1840, to a cultivated cypress drawn from the temple groves of Yunnan, China, *C. Duclouxiana* Hickel. A rhododendron from the Chinese province of Kweichow, *R. Lyr Léveillé*, provides the occasion for a very interesting discussion by the editor, Dr. Otto Stapf, of the limestone area in this province, studied first by the French missionaries and later also described by Sir Alexander Hosie in his book "On the Trail of Opium." Kweichow has the reputation of being one of the deforested provinces of China, but in this dry limestone plateau, with peaks climbing to more than 2000 m., with a temperate climate save in the deeply cut valleys where it is sub-tropical, rhododendrons are described as growing in profusion. The limestone is said to be triassic in character. It will be interesting to learn whether the rhododendrons gathered from this area prove tolerant of limestone soils in Great Britain.

**RATOON COTTON.**—Some observations upon the fibre obtained from ratooned cotton plants in Queensland were mentioned recently in these columns (*NATURE*, January 31, p. 171). James Templeton, botanist to the Ministry of Agriculture, Egypt, in Bulletin No. 55 of the Technical and Scientific Service of the Ministry, discusses the causes which have led to the disappearance of ratooned cotton from the Egyptian supply. Templeton points out that after its introduction in 1921, cotton was usually grown as a perennial crop, and that the change to cultivation as an annual may be traced to a practice prevailing upon the better lands when the cultivators were compelled by Mohammed Aly to grow the plant, although

then a relatively unprofitable crop. The perennial method of cultivation still persisted over large areas, until prohibited by the Government in 1912 as part of a campaign against insect pests thought to be harboured over winter by the standing crop. Templeton finds no evidence that the cultivation of the plant as a perennial was given up because ratooned cotton proved to be of inferior quality. As the result now of actual experiment he records with Sakellarides an increased yield of lint in the second year with quality probably not inferior. Furthermore, in the second year, the loss from boll-worm attack has not been so great as in the first year.

**EXTINCT ELEPHANTS IN ENGLAND.**—The elucidation of the inter-relationship of the many forms of Pleistocene elephants is a most difficult problem, especially when it is remembered how fragmentary the evidence is. A valuable paper has recently been published by Dr. Sandford in the *Quarterly Journal of the Geological Society*, vol. 81, No. 321, on "The Fossil Elephants of the Upper Thames Basin." This paper, together with one on "The River Gravels of the Oxford District" in the same journal for 1924, form an opening attack by Dr. Sandford on the general problem of the evolution of the elephants of the period. The author finds *E. antiquus* of an archaic type in the Handborough Terrace Level and in the Wolvercote Channel, a later level, specimens of a smaller form of the species which appear to be akin to the small form found at Barrington and in the Forest Bed. *Elephas primigenius* occurs in the Summertown-Radley Terrace and *E. antiquus* is again found in a level overlying this, which points to a warm phase following a colder one.

**TIDES AND CURRENTS IN NEW YORK HARBOUR.**—Under this title the U.S. Coast and Geodetic Survey has recently published a connected account by H. A. Marmer of the chief movements of the various tidal waters in the neighbourhood of New York. Observations at a large number of stations both on shore and off shore have been taken at various times, partly by the Survey itself and partly by the U.S. Engineer Office, and these afford material for a descriptive account which is exceptional in its completeness. An idea of this completeness may be gathered from the fact that the pamphlet contains 70 tables and 52 diagrams. Fort Hamilton, which occupies a central position in the region considered, is chosen as the standard station, and the characteristics of the tidal elevation at this place are summarised in 48 non-harmonic constants. Harmonic constants are given for the currents at Scotland Light Vessel, Ambrose Channel Light Vessel, and the Narrows, the results for each of the first two of these stations being based on hourly observations extending over 87 days. In several instances the elevation-gradients transverse to the current are connected with the currents and the earth's rotation in close agreement with dynamical theory. The currents in East River turn about half an hour after the waters at its two ends reach the same level, while the non-periodic flow from the Hudson River decreases in strength from the surface downwards. The monograph closes with a set of 13 maps, showing the states of the tide and current for each hour relative to the time of high water at Fort Hamilton. The pamphlet is well written and shows a regard for precision which is very welcome.

**MEASUREMENT OF ATMOSPHERIC HUMIDITY.**—Hygrometric tables have been prepared by the Meteorological Office, Air Ministry, for the computation of relative humidity, vapour pressure, and dew point from readings of dry and wet bulb thermometers

exposed in Stevenson screens (H.M.S.O., 1s. 6d. net). The tables have been brought into use for obtaining data for publication from the commencement of the current year. Hitherto the tables in use in Great Britain were based on constants known as Glaisher's factors, said to be drawn up on an empirical formula. The new tables have been freshly computed on the basis of Regnault's formula and may be taken as practically identical with similar tables prepared by the Austrian Meteorological Service—with a light air blowing. They are not suitable for factories or store-rooms, unless precautions are taken to secure adequate motion of the air. The tables are, strictly, more scientific than those hitherto used in England and are in agreement with the best in use in other countries. Formulæ are given so that in countries where temperatures are common outside the scope of the tables, it is recommended to expand the table by computing other values. The preface by Dr. G. C. Simpson, the Director of the Meteorological Office, states that the results given by Glaisher's tables are in practical agreement with those obtained from the most recent tables based on Regnault's formula. Hygrometric tables based on Glaisher's factors were expanded and issued for private circulation by the Meteorological Office nearly half a century ago, and it is a satisfaction to know that the results used for so many years differ so slightly from the results which are the best obtainable to-day. The tables are very concise.

**VAPOUR PRESSURES OF FUEL MIXTURES.**—Considerable attention has in recent years been devoted to the problems of vapour pressure of those liquids or liquid mixtures used as fuels in internal combustion engines. Such matters as loss incurred on handling or storing fuel, internal pressures developed in tanks or other containers used for transporting fuel, fire risk, and the facility with which fuel is vaporised in carburettors all depend on the vapour pressure of the liquid at or just above ordinary temperatures. Mr. J. Stanley Lewis discussed this subject recently at the Institution of Petroleum Technologists, and gave the results of several careful vapour-pressure determinations on binary and ternary mixtures. Starting with hexane and benzene, he showed that there is a rise in vapour pressure caused by traces of water, and that calcium chloride as a desiccant is inefficient. The author employed phosphorus pentoxide more satisfactorily in this connexion. He next gave results of vapour-pressure determinations on fractions of petrol and mixtures of the fractions, on mixtures of benzene with hexane and cyclohexane, and on motor benzol with No. 1 and No. 3 petrol. Other mixtures investigated include benzene and alcohol, ethyl alcohol and No. 1 petrol, ethyl alcohol and No. 2 petrol, and alcohol and water. An example of a ternary mixture is given by the fuel benzol and alcohol plus the small amount of water existent in commercial alcohol, while a petrol-alcohol-water mixture constitutes a similar case. Briefly stated, the addition of one component to a mixture of the other two raises the vapour pressure, and for a given concentration of a ternary mixture there will be a fourth (highest) maximum vapour pressure. In binary fuel mixtures, where the two components are completely immiscible, the vapour pressure of the mixture is the sum of their partial vapour pressures; where there is partial or complete miscibility the vapour pressures vary according to the degree of concentration of the components, and may lie between or be higher or lower than that of either component.

**FATIGUE STRENGTH OF STEELS.**—Messrs. Aitchison and Johnson presented the results of an investigation

on "The Effect of Grain upon the Fatigue Strength of Steels" at the May meeting of the Iron and Steel Institute. This work was carried out on behalf of the Engineering Research Board of the Department of Scientific and Industrial Research, which made a grant towards its cost. The test results have been obtained by examining a complete series of specimens, commencing with a large steel cast ingot, followed by specimens at different stages of forging, the final specimen representing a reduction in cross-sectional area of 96 per cent. of the original casting. In addition, tests were made upon commercial mild steels, high quality nickel chromium steel, Staffordshire wrought irons, and Armco iron. The report deals mainly with the mechanical properties particularly the fatigue strength of steels when tested parallel to and at right angles to the direction of elongation during forging. The authors find that the direction of the grain has a marked influence upon the ductility recorded in the tensile test, and upon the toughness as measured by the impact test. The maximum stress of the material is not appreciably different in the two directions, nor is there such a large difference in the fatigue strength as had been anticipated. The authors always found that the values of this property were higher in specimens cut parallel to the direction of forging than in those cut at right angles. The maximum difference found is 16-17 per cent.

**LITHIUM SOLUTIONS IN LIQUID AMMONIA.**—C. A. Kraus and W. C. Johnson have recently measured the vapour pressures of solutions of lithium in liquid ammonia. The results, published in the March issue of the Journal of the American Chemical Society, afford no evidence of the existence of compounds of the alkali metals with ammonia of the nature of ammonium groups. The saturated solution contains 3.61 molecules of ammonia per atom of lithium.

**MAGNETIC PROPERTIES OF SILVER HALIDES.**—Recent work by A. Garrison, recorded in the March issue of the Journal of the American Chemical Society, shows that silver chloride is diamagnetic and becomes less so on illumination, whereas the bromide and iodide are slightly paramagnetic and become more so on exposure to light. These changes on illumination are instantaneous. It is pointed out that a change in the magnetic permeability would naturally accompany an increase in electrical polarity, an occurrence which is suggested by the fact that the absorption of light causes the halides to be more soluble in water and better conductors of electricity.

**SOAP SOLUTIONS.**—An interesting paper by J. W. McBain and G. M. Langdon on the equilibria underlying the soap-boiling processes appears in the Journal of the Chemical Society for April. The investigation consisted in the examination of the sodium palmitate—sodium chloride—water system, and phase rule diagrams are given for a series of temperatures. In any soap system the following phases can exist: lamellar crystals, crystalline curd fibres, anisotropic liquid "neat soap," anisotropic liquid "middle soap," and isotropic liquid. Soap-boiling operations depend on the equilibria between these phases. "Neat soap," "middle soap," and "isotropic solution" are three forms of soap solution proper; the first two are anisotropic (doubly refracting). Isotropic liquid solutions of sodium palmitate form a phase which includes wholly colloidal and wholly crystalloidal solutions within the temperature range investigated. Pure water and pure anhydrous liquid sodium palmitate are miscible in all proportions above 316°. The contents of the commercial soap can behave approximately as a simple three component system, apart from crystallisation.

## The South-Eastern Union of Scientific Societies.

ANNUAL CONGRESS AT FOLKESTONE.

THE thirtieth annual congress of the South-Eastern Union of Scientific Societies was held at Folkestone on June 3-6 inclusive. At the opening meeting and before leaving the chair after his year of office, Sir Richard Gregory presented in the name of the Union an illuminated address to Mr. H. Norman Gray, former secretary to the Union. Sir John Russell, director of Rothamsted Experimental Station, then assumed the presidential chair, and delivered his address on "The Place of Science in Rural Life." He traced the changes in the manner of manuring since the empirical days of the ancients, citing as an instance the twelfth-century writer, Idn-el-Awam, who said that human blood stimulated decomposition of manure-heaps and gave a valuable fertiliser. Science was first introduced into rural life when in 1834 Boussingault began analysing his crops and manures. In comparing the output per man on a Sussex farm it was stated that in 1881 it took 117 man-hours to grow one ton of wheat, but only 82 in 1921. "A clod of earth is a storehouse of wonders which are being patiently explored in the experimental stations and colleges."

In the Botanical Section Mr. A. G. Tansley, F.R.S., drew a large audience to hear a paper on "The Vegetation of the Southern English Chalk." He explained the various ecological factors of the chalk, and touched upon plant communities, the pioneer vegetation, the chalk grassland, the chalk scrub, the chalk woodlands, beech forest, the succession of vegetation on the chalk, and the factors arresting the succession in various stages.

In the Geological Section Mr. A. G. Davies directed attention to the many sections that are being temporarily exposed in the progress of excavations for new arterial roads. Mr. Davies has done a good deal of work around London, and in particular dealt with the widening of the main Brighton road at and about Merstham, and cuttings and borings between that point and London, the latter part being examined in detail in the boring of the Tube from London to Merton, the strata covering from the base of the Chalk to the top of the London Clay. An interesting and fruitful section at Woodfield Hill showed an exposure of 400 yards in the *Holaster planus* zone, with a continuous section of the Chalk Rock or Reussianum band, perhaps one of the finest sections of Chalk Rock in Britain. Much new palaeontological work has been

done on the section. From the Clapham Road portion of the Tube in the London Clay the "sea-serpent" of Owen, *Ophida toliapicus*, was rediscovered after the lapse of nearly a century.

Mr. D. Ward Cutler made a valuable contribution in his paper on "Life in a Garden Soil." There is a vast assembly of little-known creatures in a piece of garden soil. It had long been suspected that in sewage beds the conversion of ammonia into nitrate was not a chemical but a biological process, but not until 1880 was it shown that the process involved two stages, associated with two organisms, and the organisms were isolated in 1911. All decomposition and purification of the soil is now known to be due largely to the activities of bacteria.

The Regional Survey Section listened with interest to Mr. Geo. L. Pepler on "Surveys as Preliminaries to Town Planning," and in the Zoological Section Mr. E. C. Stuart Baker gave a brilliant address on "Field Naturalists and Evolution," to illustrate which he brought many cuckoos' eggs from his collection, showing gradations in size and markings between the eggs of the foster parent and those of the cuckoo from decided diversity to perfect resemblance.

In pursuance of the custom of recent years of bringing to notice the uses of the cinema for educational purposes, a lecture was arranged at the Picture Theatre, at which some hundreds of children were present, when Dr. Clarence Tierney lectured to them on "Some of Nature's Secrets." Mr. E. A. Martin raised some controversial points in his paper on "Some Controversial Points in Anthropology." He suggested that the differences of opinion as to the age of the human jaw discovered in Kent's Cavern should be adjudicated upon by a committee of experts. In dealing with the pictorial representations of the human form on palaeolithic cave-walls, he made the suggestion that we may have here preserved what were really monstrous forms of the human race, when the species was scarcely fixed and the race was still in a plastic condition.

Many interesting excursions were made, amongst them being one to what has been called the finest Roman site in the south-eastern counties, and another to Dungeness point, rendered famous of late years on account of the supply of fresh water which is to be found within three or four feet of the gravel surface.

## The Calculation of World Temperatures.

MATHEMATICAL expressions giving the variation of air temperature with such factors as time and latitude have been obtained by a number of different meteorologists by evaluating the several coefficients in a Fourier series. Mostly the investigations have been confined to conditions existing in a particular locality, and in only a minority of cases have world conditions been considered. When only one locality is considered, the task is comparatively straightforward. If, however, the whole world is dealt with, the accuracy of the results will be limited by the number of observing stations existing over the earth, and more particularly by their distribution. To obtain satisfactory mathematical relations a series of observations extending over a considerable number of years is necessary. Over the more densely populated parts of the earth it is usually possible to make a selection of stations which shall be fairly representative of the whole area, but over many large areas

no information exists at all. Over other large areas the observing stations are very sparsely distributed, and to obtain results which are true on the average for the whole area is correspondingly more difficult.

The author in the publication before us<sup>1</sup> has dealt first with the simpler case, taking Brussels as the locality to be considered, and afterwards he has extended the investigation to cover the whole globe. This very considerable task was undertaken during the War, when night astronomical observations at the Royal Observatory of Belgium were forbidden by the German military authorities.

The maximum, minimum, and mean temperatures for Uccle extending over a period of 75 years have been extracted from *L'Annuaire Météorologique* for 1908 and used to establish general mathematical expressions which will give for any date in the year the

<sup>1</sup> "Expression analytique des variations de la température de l'air." Par H. Philippot. Pp. 48. (Bruxelles: M. Hayez, 1921). 5 francs.

mean temperature, mean maximum, mean minimum, absolute maximum, and absolute minimum temperatures. The values of each of the five elements for every day in the year are stated in tabular form.

In extending the relations to different parts of the globe, recourse has been made to Hann's "Lehrbuch der Meteorologie" for information relating to 143 stations, coastal and inland, scattered over the two hemispheres, and the results for Brussels and Nertchinsk are added to these. Expressions have been obtained for the same five temperature means and extremes for all of these stations, while for 26 of them more exact expressions have been calculated. The accuracy of these latter expressions may be gauged when it is stated that the difference between the observed and calculated monthly mean temperatures in no case amounts to  $1^{\circ}\text{C}$ ., and in most cases is a small fraction of this amount.

To progress from the results for individual stations, the earth's surface is divided into belts of  $10^{\circ}$  of latitude. For each belt the mean latitude is obtained for the stations contained in the belt and also the mean of their respective temperatures. The results obtained for the successive belts are then integrated to obtain a mean temperature for the whole globe and for each hemisphere. The values obtained are: (1) for the whole globe,  $15^{\circ}61\text{C}$ .; (2) for the northern hemisphere,  $16^{\circ}15\text{C}$ .; and (3) for the southern hemisphere,  $15^{\circ}07\text{C}$ . These results are somewhat higher than those given by Angot in his "Traité de météorologie." This may to a certain extent be accounted for by the fact that no allowance has been made by the author for the relative amounts of land and water in his successive belts of  $10^{\circ}$  of latitude, as was done

by Spitaler and Forbes in their calculations. The difference between the observed mean temperature at any place and the value calculated for that latitude gives a measure of the effects of topography and local conditions, such as nearness to the sea, the direction of prevailing winds, the influence of ocean currents, etc. These effects of continentality and oceanity have further been considered as equivalent to a change of latitude, and examples are given for different places the mean temperature of which is equal to that for latitudes considerably nearer the equator or the poles.

The amplitude of the temperature oscillations has been similarly considered, because this is also dependent upon latitude, and the difference between the observed and the calculated amplitude will again be due to local conditions, the climate being more or less equable than is general for the latitude. The effects of continentality and oceanity on both mean temperature and its amplitude are shown on charts.

A possible allocation of dates is suggested for the meteorological seasons based on temperature changes. The dates for the change of seasons would be those where the maximum, minimum, and mean temperatures were passed. To a first approximation for places outside the torrid zone, the dates obtained (January 22, April 24, July 24, and October 23) are about one month later than the corresponding astronomical seasons.

The author concludes that the really determining factor in temperature is latitude, and that the other conditions, topographical or local, give rise only to more or less important perturbations the effects of which can be obtained by direct observation alone.

R. S. R.

### Botanical Exploration in China.

THE *Anzeiger* of the Vienna Academy of Sciences for 1924, which has recently been issued, contains, among other interesting matter, parts 25-30 of Dr. H. Handel-Mazzetti's "Plantae Novae Sinenses." They add another century of new species and varieties of Chinese plants to those included in the earlier numbers. There is no definite plan in the selection of the plants described as new. The descriptions are rather in the nature of gleanings obtained in the course of the author's elaboration of the extensive material which he collected during his five years' exploration work in China, and of preliminaries towards a full account of his expedition. This, we understand, is almost ready for the press, and as Dr. Handel-Mazzetti is not only a highly competent botanist and an experienced traveller—he has done good work in Kurdistan and Upper Mesopotamia—but also a naturalist with a very comprehensive and thorough training, we are eagerly looking forward to its publication.

Dr. Handel-Mazzetti went to China with Camillo Schneider, the well-known dendrologist, early in 1914 on behalf of the Austrian Dendrological Society and with the support of the Vienna Academy of Sciences, the immediate object of the expedition being the Upper Yangtse basin between  $27^{\circ}$  and  $30^{\circ}\text{N}$ . The travellers left Yunnan-fu in March 1914 and devoted themselves during the spring and early summer to the exploration of the Yalung basin in southern Szechuan and of the north-western corner of Yunnan. When Schneider left in July for America, Handel-Mazzetti continued the work alone. He returned to Szechuan in the autumn, going afterwards to Mengtse and Manhao on the Red River and, in the spring of 1915, to Yunnan-fu, whence he started for the Likang range, crossed the Mekong, and penetrated to the watershed of the Salween and the Kiukiang, the easternmost tributary of the Irawadi. The next

year was given up to the exploration of the Upper Salween basin as far as its western and northern boundaries. After having spent the winter of 1916-1917 at Yunnan-fu, Handel-Mazzetti turned his attention to the botanically very incompletely known provinces of Kweichou and Hunan. He traversed southern Kweichou from west to east and reached Changsha in Hunan towards the end of 1917. The following summer saw the explorer in Central and South-West Hunan. After another winter in Changsha, which was spent in preparing his extensive collections for despatch to Europe, Handel-Mazzetti left China, arriving in Vienna in the early summer of 1919.

Dr. Handel-Mazzetti published preliminary accounts of the floral zones and plant formations of West Szechuan and Yunnan in the *Anzeiger* in 1916, 1917, and 1920, and a revised account in Engler's "Botanische Jahrbücher," Band 56, with a map (1921), whilst a similar account dealing with the flora of Kweichou and Hunan appeared in the *Sitzungsberichte* of the Vienna Academy in 1919. A preliminary report on his exploration in Yunnan may be found in the *Mitteilungen* of the Geographical Society of Vienna in 1919 and a paper "Ergebnisse der Expedition Dr. Handel-Mazzetti's nach China, 1914-1918. Neue Aufnahmen in N.W. Yunnan und S. Szechuan," accompanied by a map, in the *Denkschriften* of the Vienna Academy in 1921. The latter contains important contributions to the glacial geology of the country and is repeatedly referred to in J. W. and C. J. Gregory's recent memoir on "The Geology and Physical Geography of Chinese Tibet" (Phil. Trans. Roy. Soc., London, Ser. B., Vol. 213). Dr. Handel-Mazzetti, who is an excellent photographer, has also made a fine collection of slides (partly coloured), many of which are of great beauty.

O. S.

## University and Educational Intelligence.

CAMBRIDGE.—The Council of the Senate has nominated Mr. Ernest Harrison, senior tutor of Trinity College, for the post of Registrar of the University, on the resignation of Dr. J. N. Keynes.

The special Board of Biology and Geology has nominated P. R. Cuvati, to use the University Table at Naples.

An annual grant of fifty guineas is to be made from the University to the Marine Biological Station at Plymouth.

The honorary degree of Doctor of Science has been conferred on Prof. J. Joly, professor of geology and mineralogy in the University of Dublin, and on Dr. A. P. Maudslay, distinguished for his contributions to the archæology of Central America and Yucatan.

DURHAM.—Dr. Thomas Alty, lecturer in physics, has accepted an invitation to a chair of physics in the University of Saskatchewan. Dr. Alty was Oliver Lodge fellow and prizeman of the University of Liverpool in 1921, and while at Trinity College, Cambridge, he worked with Sir J. J. Thomson at problems of bubble-surfaces; this research he has developed while in his post at Durham.

Three further lectureships have been established in the departments of applied mathematics, geology, and botany; these have been filled respectively by Mr. E. F. Baxter, assistant lecturer in mathematics at the University of Sheffield; Mr. William Hopkins, research student of Armstrong College, Newcastle; and Miss Elsie Phillips, Isaac Roberts scholar and demonstrator in botany at the University of Liverpool. The report of the Department of Pure Science at Durham shows that during this, its first session, ten papers on original work will have appeared and that the entry-list for 1925-6 is full.

LEEDS.—On the nomination of the Senate, Prof. J. W. Cobb has been elected Pro-Vice-Chancellor of the University in succession to Prof. Jamieson, whose term of office expires at the end of this month. The Council has agreed to co-operate with the City Council in extending an invitation to the British Association to hold its annual meeting in 1927 at Leeds.

LIVERPOOL.—The honorary degree of D.Sc. has been conferred on Sir J. C. Irvine, Principal and Vice-Chancellor of the University of St. Andrews; and the honorary degree of D.Eng. on Sir Dugald Clerk, formerly Director of Engineering Research at the Admiralty, the distinguished authority on gas and oil engines.

LONDON.—Miss Helene Reynard has been appointed Warden of the Household and Social Science Department, King's College for Women. Miss Reynard, who was for some years resident junior bursar of Girton College and is now treasurer and secretary of Somerville College, will take up her new duties early in October.

MANCHESTER.—The following appointments in the Faculty of Technology have been made: Dr. T. K. Walker to be lecturer in applied chemistry; and Miss Marion Chadwick and Mr. A. Hancock to be assistant-lecturers in applied chemistry.

OXFORD.—The annual report of the Delegates of the University Museum, lately published, contains a detailed account of the teaching given and the researches performed in the various scientific departments of the University, together with a notice of the additions made during the past year to the Museum

collections. These, in several of the departments, have been both numerous and interesting. The list of accessions to the Pitt-Rivers museum covers five large quarto pages.

Preparations for the visit of the British Association in 1926 are in active progress. Some of the committees have already met, and an office has been secured for the local secretaries.

The Boyle Lecture, delivered by Prof. J. Joly, dealt with the geological age of the earth, estimated by the carrying of salt into the sea by rivers, and by the radioactive decay of thorium and uranium. The results of these different methods were shown to be fairly accordant.

In the Halley Lecture, delivered on June 17, Dr. W. W. Campbell, President of the University of California and Director of the Lick Observatory, discussed the position and constitution of the star-group to which the solar system belongs, in relation to the stellar universe.

The members of the Universities Commission are nearing the end of their labours. The Statutes of all or most of the Colleges have now undergone their final revision.

MR. BERNHARD BARON, of Brighton, has given a sum of 10,000*l.* to the Jewish University in Jerusalem.

SINCE the Imperial College of Science and Technology, South Kensington, was founded by Royal Charter in 1907, questions of its relationship to the University of London have been under discussion. The College includes as integral parts the Royal College of Science, the Royal School of Mines, and the City and Guilds (Engineering) College, and it possesses the fullest equipment for the most advanced training and research in various branches of science. Unlike University College and King's College, it is not incorporated in the University of London, though for the purpose of internal degrees of the University it was admitted as a school of the University in the Faculties of Science and Engineering in 1908. The courses of work at the College do not, however, follow the University syllabuses, being distinctive from them both as regards method and content. In spite of this, many of the students take science degrees in the University in addition to their College diplomas; indeed, the diploma courses are of equal standard to those required for honours degrees at the University. The duplication of effort and examination thus involved will in future be avoided through a scheme which has been accepted by the governing body of the College and the University senate for the conduct of final B.Sc. (Special) and B.Sc. (Eng.) examinations for students of the College. The University has adopted the College examinations as its own and will appoint the internal examiners of the College to be its own examiners while it will, in addition, appoint its own external examiners. The scheme is a simple, business-like arrangement that might be made between any first-class college and any recognised university; but it really represents a very big step in principle, and marks the beginning of an entirely new era in university education. It means that the Imperial College retains its individuality in methods of training while the University examinations are subordinated to the teaching instead of, as hitherto, the teaching being controlled by the examinations. For this satisfactory solution of a long-standing problem Sir Thomas Holland, Rector of the Imperial College, is largely responsible, and we congratulate both the College and the University upon the friendly spirit in which the scheme now established has been discussed and secured.

## Early Science at Oxford.

June 24, 1684. Mr. Musgrave further informed the Society that if ye Jugular veins in men communicate one with ye other, in ye same manner, as they did in his Dog, we may then argue hence, that bleeding in ye jugulars, is more proper in some distempers of ye head, than severall physitians (who suppose no considerable communication between ye brain, and externall jugulars) will allow.

It was ordered, that ye Eclipse of ye Sun, on ye 2nd of July next, be strictly observed, and that all things necessary for that purpose be made ready by that day.

Mr. Walker mentioned a Barometer he has, ye tube of which, at about 27 inches from ye open end, turnes in an obtuse angle, for ye better observing ye ascent of ye quicksilver. He was desired to shew it ye Society at ye next meeting.

June 26, 1688. The thanks of the Society are returned to Mr. President, for a letter communicated by him from Mr. Hillyer, being a farther account of customs and religion of ye Indians.

In consideration of the great pains and trouble Dr. Wallis has been at in the care of printing *Aristarchus*, the Society give order that their thanks be returned to the Doctor.

Ordered that an *Aristarchus* be sent to Dr. Garden, one to Dr. Middleton. To the Vniversitys of Aberdeen, and Glasgow, Edinburgh and St. Andrews. To Mr. Molineux, and the Provost and Library of Dublin. To Mr. Ash. To Mr. Jessop. To Dr. Lister. To the Secretarys of the Royall Society, and the Library of the Society, and the President of the Royal Society. To Dr. Chamberlain. To Mr. Flamsteed. To Dr. Pitt. To the Vice-chancellor and Publick Library. To Mr. Halley. Ordered that Mr. Charlet deliver one from the Society to Mr. President.

The Tutenage of Japan was shewed to the Society, being used for paper to wrap up goods, or make sacks: Of the same sort being thicker are made the tea-pots. It is a metall finer than lead or tin, but neither the one nor the other. The thanks are returned to Dr. Hide for his communication of the heads of some Japan matters he has communicated to ye Society.

June 29, 1686. Mr. Caswell communicated part of a letter from Mr. Halley, wherein he acquaints him that he intends to try some experiments concerning the specific gravity of the air. A discourse of Dr. Lister's read, concerning the improvement of *Agriculture*.

July 1, 1684. Mr. Walker presented his Barometer, mentioned in ye Minutes of ye præceding week, to ye Society; ye tube of it, at ye distance of (about) 27 inches from ye upper end, was bent, in an angle of 108 degrees for ye better observing ye motion of ye quicksilver, which, in ye sloaping part of this tube, does rise, and fall,  $2\frac{1}{2}$  inches, for one inch in a tube exactly perpendicular.

Mr. Bernard was pleased to acquaint ye Society, that a spot in ye Sun was seen by Mr. Caswell on Thursday last, and by himself at  $\frac{1}{2}$  hour after 7 in ye morning, at which time it was not far from ye rim of ye Sun: it appeared to be a thick firm spot, and to take ye same course, with that observed, not long since, by Mr. Flamsteed, (*vid.* Minutes of May 27, 1684;) for it passed over near ye center of ye Sun. He tells us farther, that he looked after it again on ye Monday following but could not see it, it had made its exit. We are promis'd a more full account of this matter.

Dr. Bathurst informed ye Society, of a relation he lately received out Somersetshire, concerning ye great damage done to ye beans in that county, by vast numbers of caterpillars.

## Societies and Academies.

LONDON.

Royal Society, June 18.—Lord Rayleigh: Luminous vapour from the mercury arc and the progressive changes in its spectrum. This investigation deals with the luminous stream of vapour observed when mercury distils away from the arc *in vacuo*. The lines of the arc forming known spectrum series are for the most part strongly developed in the vapour stream. An exception is line 1850  $\text{rP} - \text{rS}$ , which is strong in arc, but inconspicuous in vapour. Higher members of various series appear in greater relative intensity in vapour than in the arc. The continuous spectrum of mercury, not noticeable when the vapour first emerges, becomes more conspicuous as the vapour matures. In the limit the spectrum tends to consist simply of line 2537 and continuous spectrum. If the vapour is passed through a metal tube maintained at negative potential, the luminosity of the line spectrum in general tapers down to a sharp point, beyond which it disappears. Line 2537 behaves differently. Much of its light tapers down to a point which, however, is beyond the place where the other lines are extinguished, but a residuum is of a different origin and does not admit of extinction. The light of the band spectrum also passes on.—J. C. McLennan and G. M. Shrum: On the origin of the auroral green line 5577 Å and other spectra associated with the aurora borealis. In studying the effect of large admixtures of helium on the spectrum of oxygen, a hitherto unknown line has been photographed. The wave-length of this line has been found to be  $5577.35 + 0.15$  Å. It is very sharp and is subject to great fluctuations in intensity. Evidence has been produced to prove that this line is identical with the auroral green line  $\lambda = 5577.350 + 0.005$  Å. This line must be attributed to some hitherto unknown spectrum of oxygen, and it is not a limiting member of the ordinary band spectrum of oxygen. Helium has been used to bring out the bands of nitrogen, with an intensity distribution similar to that found in the aurora. The possibility of metastable helium acting as the exciting agent in the auroral spectrum has been discussed.—J. C. McLennan and A. B. McLay: On the series spectrum of gold. Absorption spectra of the vapours of gold, silver and copper in the Schumann region have been investigated. The second members of principal series of doublets in the gold arc spectrum are  $\lambda = 1646.71$  (I vac.) and  $\lambda = 1665.75$  (I vac.). Similarity exists between the term systems gold I, copper I, and zinc II, in respect of their inverted  $\delta$  terms, and the term systems of gold I and copper I in respect to certain special  $\pi$  terms. The term systems silver I and cadmium II have not been shown to include either inverted  $\delta$  terms or the special type of  $\pi$  terms mentioned.—W. A. Bone, D. M. Newitt and D. T. A. Townend: Gaseous combustion at high pressures, Pt. V. The authors describe further experiments upon the explosion of hydrogen—air and carbon monoxide—air mixtures at initial pressures up to 175 atmos. It is shown, *inter alia*, that, in general, and except where  $\text{N}_2$ -activation intervenes, as in carbon-monoxide-air explosions, time for the attainment of maximum pressure diminishes as initial pressure increases. The "corrected"  $P_m/P_i$  ratios for explosion of any and all mixtures investigated increased in notable degree with initial firing pressure, due probably to increasing opacity of the gaseous medium to the radiation emitted during explosions. There were no signs of "after-burning" in any of the explosions when  $P_i$  exceeded about 10 atmos., although it could usually

be detected when  $P_i = 3$  atmos.—W. T. David: The effect of infra-red radiation upon the rate of combustion of inflammable gaseous mixtures. Two types of apparatus were employed: In one, radiation from an electrically-heated wire coil was passed into the explosion vessel through a window of fluorite or quartz. Pressure-time curves were taken during the explosion of identical mixtures, first when radiation was passed into the explosion vessel, and then when no radiation was passed in. In the other, gaseous mixtures were exploded in a vessel the interior surface of which was silver-plated, and could, therefore, be made either reflecting (by polishing) or absorbent (by coating with dull black paint); by this means it was possible to vary the radiation density of those types of radiation emitted by the burning gases during the explosion period. Pressure-time curves were taken during explosion of identical mixtures taken first when the walls of the vessel were polished, and then when blackened. For hydrogen and air, carbon-monoxide and air, and methane and air mixtures, an increased rate of combustion was found in all cases when the superimposed (first type) or increased (second type) radiation could be absorbed by the reacting gases. Absorption of radiation by reacting gases promotes combustion; intra-molecular energy (rotational and vibrational) of reacting molecules is the factor (or one factor) concerned in combustion.—R. K. Schofield and E. K. Rideal: The kinetic theory of surface films. Surface tension—concentration curves for aqueous solution of a number of capillary active organic substances give evidence in the case of dilute solutions in support of the unimolecular character of the adsorbed films. The analogy between the lowering,  $F$ , of the surface tension, and a three-dimensional gas or osmotic pressure, postulated by Traube, has been critically examined. For weak solutions when  $F$  exceeds some 10 dynes per centimetre, the surface phase is relatively highly condensed, and the equation  $F(A-B) = \kappa RT$ , analogous to that of Amagat connecting the pressure and volume of highly compressed gases, is obeyed. In this equation,  $A$  is area occupied by a gm. mol. of active substance at interface,  $B$  is limiting area of a gm. mol. under high compression, and  $1/\kappa$  is a measure of lateral molecular cohesion. The values of  $\kappa$  for fatty acids show that at a water-air interface, lateral molecular cohesion increases with length of hydro-carbon chain. There is little or no cohesion between such molecules at a water-benzene interface. Sucrose molecules do not cohere at water-mercury interface.—H. M. Macdonald: The condition that the ratio of the intensities of the transmitted and reflected electric waves at the interface between two media is independent of their plane of polarisation. For a state of steady electrical oscillation between a closed surface separating two different dielectric media and a conductor inside this surface, the condition is that the ratio of the specific inductive capacities of the two media is equal to the ratio of their magnetic permeabilities. For a medium in which the ratio of the specific inductive capacity to the magnetic permeability is constant, the intensity is constant along a ray which cuts the surfaces of constant specific inductive capacity orthogonally; when the surfaces of specific inductive capacity are concave towards an inner surface, and the specific inductive capacity diminishes outwards, the path of any other ray is concave towards the inner surface.—C. V. Raman and L. A. Ramdas: The scattering of light by liquid boundaries and its relation to surface-tension. Parts I. and II.—H. Weiss: The application of X-rays to the study of alloys.—F. R. Weston: The flame spectra of carbon monoxide and

water gas. The results of a spectrographic study of the flame of carbon monoxide, burning in air and various other supporting atmospheres, are described. In the flame of pure (undried) carbon monoxide, two sets of independent interactions occur simultaneously.—(a) *direct* interactions between CO and O (*without any intervention of steam*), exciting radiations which give rise to the continuous and banded parts of the spectrum and to the characteristic blue colour of the flame, and (b) interactions between CO and OH<sub>2</sub> molecules, which originate the "steam-lines" in the spectrum. When water is gradually added to the burning gas, the latter proportions of the first-named interactions diminish rather rapidly.

## CAMBRIDGE.

Philosophical Society, May 18.—J. F. Lehmann and T. H. Osgood: The passage of electrons through small apertures. The velocity distribution was investigated in a beam of electrons emerging through an aperture in an anode to which they were accelerated by potential differences varying from 200 to 1000 volts. For holes in thin sheet copper, the percentage of electrons in the beam with velocities equivalent to the accelerating field, as measured by retarding potentials, varied from 1 to 80 as the diameter of the hole was increased from 0.13 to 3.24 mms. With copper capillary tubes of the order of 1 cm. in length, the percentages were much higher for a given diameter, a 0.4 mm. tube giving an 80 per cent. beam. This was the maximum attained under the experimental conditions.

## PARIS.

Academy of Sciences, May 25.—M. d'Arsonval: A new direct-current generator giving 500,000 volts. In principle this consists of a condenser charged to high potential by means of a high-tension alternating current; the alternations being separated by a two-electrode valve. With a potential of 600,000 volts (continuous) a spark passes between 50 cm. spheres, 28 cm. apart: the current is about 30 milliamperes.—Jean Perrin: Remarks on the preceding communication. If the range of the generator described can be extended to 5 million volts, it should be possible to act on the atomic nuclei and carry out transmutations on a tangible scale.—A. Desgrez, H. Bierry, and F. Rathery: Inorganic phosphates and hypoglycæmia produced by insulin. The injection into an animal of a suitable dose of a solution of sodium or potassium phosphate, with a  $P_n$  approximating to that of the blood, intensifies and prolongs the hypoglycæmia caused by injections of insulin.—C. Camichel, L. Escande, and M. Ricaud: The flow of viscous liquids round an obstacle. The effect of varying velocity of flow is shown in four photographic reproductions.—R. Köhler and C. Vaney: A new gastropod producing galls on the spines of *Dorcidaris tiara*.—M. Gustave André was elected a member in the section of Rural Economy, in succession to the late L. Maquenne.—B. de Kerékjártó: Families of surfaces and of curves.—Bertrand Gambier: The asymptotic transformation of M. Bianchi and the curve of M. Picard of ruled surfaces the generators of which belong to a linear complex.—R. H. Gernay: Implicit periodic functions and periodic solutions of partial differential equations.—N. Lusin: The projective ensembles of Henri Lebesgue.—Eydoux: The flow of liquids with and without velocity potential. Application to turbine buckets.—Boris Stetchkine: The determination in an incompressible fluid of the velocity potential due to a vortex tube.—P. Lecomte du Nouÿ: An apparatus for the rapid measurement of the surface

tension at the surface of separation of two liquids. The influence of temperature.—Stephane Dombrowsky: The regime of concentrations established by lateral diffusion in a convection current.—M. Lardry: Study of the propagation of short waves (in wireless telegraphy). An account of the phenomena observed (fading, scintillation) of signals of wavelengths of 450, 115, and 50 metres at distances between 180 and 4500 kilometres. The superiority commonly attributed to the shorter wave-lengths was not confirmed.—E. Briner: Remarks on the origin of radioactivity. It has been advanced as a difficulty against the acceptance of the theory of the spontaneously explosive atom, that the enormous emission of energy accompanying this change is irreconcilable with the exothermic synthesis of the elements starting with their primordial constituents, protons and electrons. The author shows by analogies drawn from the destruction of chemical molecules that there is no real incompatibility between the radioactive atom, the destruction of which frees a large amount of energy, and the exothermic formation of the atom.—Mlle. Berthe Perrette: Contribution to the study of the isotopy of lead. A comparison of lead extracted from a pitchblende (Belgian Congo) with an atomic weight of 206.14 and ordinary lead of atomic weight 207.2. The densities were: radioactive lead, 11.278; common lead, 11.336; and both had the same atomic volume. In the comparison of the arc spectra, the Fabry and Perot interference method was used, the diameters of the rings formed by the corresponding lines of the two isotopes being measured. All the lines have shown a difference in the same sense with an increase in the wave-length for the lead with the lowest atomic weight.—Nobuo Yamada: The long range particles emitted by the active deposit of thorium. The experiments described prove that the active deposit of thorium emits only one group of  $\alpha$  particles of 11.5 cm. range, in addition to the ordinary  $\alpha$  rays. The two other groups found by Bates and Rogers were not confirmed.—d'Huart: The absorption of water vapour and of some other vapours by the surface of glass. An apparatus is described and figured which can be used to measure the amount of water vapour adsorbed by glass surfaces. It can also be used to determine the vapour density of very volatile liquids.—Paul Pascal: Magnetochemical researches on the formation of closed chains and nuclear groups in organic compounds.—Grandadam: The purification of potassium and sodium cyanides. Their melting points. The purification of the alkaline cyanides can be effected by solution and recrystallisation in liquid anhydrous ammonia. The melting points were determined in a silver crucible in an atmosphere of dry nitrogen, using a gold-silver thermocouple. Sodium cyanide melts at 564° C., potassium cyanide at 634° C.—F. Bourion and J. Picard: The kinetic study of the reduction of mercuric bromide by sodium formate.—V. Auger: A new type of alkaline borates; the pentaborates.—Pierre Lesage: Inheritance of the early character and the conservation of this character in old seeds.—P. Lavialle: The antipodes and the chazalian region of the ovule of the Dipsacæ.—Jules Amar: Cellular hydration and vitality.—J. Cluzet, A. Rochemaix, and Th. Kofman: The variations of the agglutinating power of a mixed immunoserum under the influence of a continuous electric current.—A. Vandel: Physiological amixia and incipient species in the isopod *Tricohiscus* (*Spiloniscus*) *provisorius*.—Philippe Bunau-Varilla and Emile Techoueyres: Induced antisepsis or, in other words, the microbacial action exercised at a distance, without material contact, on a bacterial dilution by a very dilute solution of sodium hypochlorite.

## Official Publications Received.

- Bulletin of the National Research Council. Vol. 10, Part 1, No. 51, March: Radioactivity. Report of Committee on X-rays and Radioactivity, National Research Council. By A. F. Kovarik and L. W. McKeehan. Pp. 208. (Washington: National Academy of Sciences.) 2.25 dollars.
- Observatoire de Zi-ka-wei. Notes de sismologie, No. 6: Étude sur les ondes de dilatation et les ondes de condensation. Principaux sismogrammes 1924. Par le R. P. E. Gherzi. Pp. 22+6 planches. (Zi-ka-wei, China.)
- Journal of the Auckland Institute and Museum for 1924-1925, adopted at the Annual Meeting held February 27th, 1925. Pp. 87. (Auckland, New Zealand.)
- Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 15, Part 3: An Enumeration of the Butterflies and Moths from Saghalien, with Descriptions of new Species and Subspecies. By Dr. S. Matsumura. Pp. 31-100. Plates 8-11. (Sapporo.)
- Imperial Department of Agriculture for the West Indies. Report on the Agricultural Survey of Grenada January-December 1924. Pp. iv +11. (Grenada.)
- The Science Reports of the Tohoku Imperial University, Sendai, Japan. Second Series (Geology). Vol. 7, No. 2: A Geological Problem concerning the raised Coral-Reefs of the Rukui Islands and Taiwan; a Consideration based on the Fossil Foraminifera Faunas contained in the raised Coral-Reef Formation and the youngest Deposits Underlying It. By Hisakatsu Yabe and Shōshirō Hanzawa. Pp. 29+6 plates. (Tokyo and Sendai: Maruzen Co. Ltd.)
- Indian Medical Research Memoirs. Memoir No. 3. Supplementary Series to the *Indian Journal of Medical Research*. Provisional List and Reference Catalogue of the Anophelini. Part 7: Provisional List of Species. Part 2: Descriptive Synopsis. By Lt.-Col. S. R. Christophers. Pp. 105. (Calcutta: Thacker, Spink and Co.) 1.12 rupees.
- Department of Commerce: Bureau of Standards. Publication of the Bureau of Standards, No. 68: Report of Board of Visitors to Bureau of Standards of the Department of Commerce for the Secretary of Commerce. Pp. iv+14. (Washington: Government Printing Office.) 5 cents.
- Hundredth Annual Report of the Committee of the Bath Royal Literary and Scientific Institution for the Year 1924. Pp. 16. (Bath.)
- Aeronautical Research Committee. Reports and Memoranda, No. 960 (E. 13): Variation of Engine Power with Height. By H. L. Stevens. (B. 4. Engines 50, T. 1952.) Pp. 8+11 plates. 9d. net. Reports and Memoranda, No. 961 (E. 14): The Variation of Engine Power with Height. By H. M. Garner and W. G. Jennings. (B. 4. Engines 51, T. 1964.) Pp. 3+6 plates. 6d. net. (London: H.M. Stationery Office.)
- Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 45, Part 3, No. 18. The Equation of Conduction of Heat. By Marion C. Gray. Pp. 230-244. 1s. 6d. Vol. 45, Part 3, No. 19: Note on Professor Whittaker's Atomic Model. By John A. Eldridge. Pp. 245-248. 9d. Vol. 45, Part 3, No. 20: Unilateral Vasodilatation on the Senile Male of the Domestic Fowl. By F. A. E. Crew. Pp. 249-251. 6d. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)
- The Physical Society of London. Proceedings. Vol. 37, Part 4, June 15. Pp. 195-267. (London: Fleetway Press, Ltd.) 6s. net.

## Diary of Societies.

### MONDAY, JUNE 29

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. W. H. Moberly: Some Ambiguities in the Retributive Theory of Punishment.

### TUESDAY, JUNE 30.

ROYAL DUBLIN SOCIETY, at 4.15.  
ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 8.15.—H. de B. Codrington: Periods in Indian Archaeology.  
INTERNATIONAL CONGRESS OF RADIOLOGY (at Royal Society of Medicine), at 8.30.—Reception.

### WEDNESDAY, JULY 1.

INTERNATIONAL CONGRESS OF RADIOLOGY (at Central Hall, Westminster), at 2.30.—Official Opening.—At 9 p.m.—Duc de Broglie: Absorption of X and  $\gamma$  Radiations and the Secondary Radiations which accompany them (Silvanus Thompson Memorial Lecture).

### THURSDAY, JULY 2.

INTERNATIONAL CONGRESS OF RADIOLOGY (at Central Hall, Westminster), at 10 a.m.

### FRIDAY, JULY 3.

INTERNATIONAL CONGRESS OF RADIOLOGY (at Central Hall, Westminster) at 10 a.m.; at 9 p.m.—Sir Berkeley Moynihan, Bart.: The Relationship of Radiology and Surgery (Mackenzie Davidson Memorial Lecture).  
GEOLOGISTS' ASSOCIATION (at University College) at 7.30.—Prof. W. W. Watts: The Geology of South Shropshire (Lecture).

### SATURDAY, JULY 4.

INTERNATIONAL CONGRESS OF RADIOLOGY (at Central Hall, Westminster), at 10 a.m.  
BRITISH MYCOLOGICAL SOCIETY (Phytopathological Excursion to Cambridge).—Prof. Sir R. H. Biffen and F. L. Engledow: The Inheritance of Disease Resistance.—F. T. Brooks and W. C. Moore: Silver-leaf Disease.—N. J. G. Smith: Helminthosporium Disease of Cereals.—D. Weston: The Control of Bunt in Wheat.—R. C. Woodward: Apple Mildew.—Mrs. M. N. Kidd: Fungal Invasion in Apples in Relation to Senescence.—S. M. Wadham: Clover Rot.—A. Smith: Perennial Rust Mycelia.—Prof. Nuttall, Dr. Hare, and Mr. Tait: Fungi Pathogenic to Man.  
PHYSICAL SOCIETY OF LONDON (at Oxford).

# Supplement to NATURE

No. 2904

JUNE 27, 1925

## The Centenary of the Discovery of Benzene.

MICHAEL FARADAY.

A FEW weeks ago we published a special supplement in connexion with the centenary of the birth of Huxley: this week we are presenting a supplement containing the principal addresses which were delivered in the Royal Institution during the celebration of Faraday's discovery of benzene. Whereas Huxley's reputation is based as much upon his championship of evolution, of freedom of thought, and of enlightened education, as upon his researches in biology, the fame of Faraday rests almost entirely upon his striking contributions to scientific knowledge. His ambit was thus more circumscribed than that of Huxley, but his discoveries were more revolutionary, both in their effects on the development of theory and in their subsequent practical applications. In the latter connexion we refer more particularly to his discoveries of magneto-electric induction and of benzene. The electrical industries, together with the industries based upon benzene, constitute overwhelming proof—if proof be needed—of the value of research in pure science.

In attempting to estimate the place of Faraday among the world's great men, one is at a loss whether to value highest his superb skill as an experimenter, the originality and perspicacity of his thought, or his greatness as a man. Comparisons are no less difficult than they are odious, but few would gainsay that in view of the scanty material means he had at his disposal, and of the fact that he did not rely upon pupils or assistants, Faraday has had few, if any, equals as an experimenter. In the sphere of thought, he was not only a master of deductive and inductive reasoning, but also he possessed the priceless gift of a vivid and disciplined imagination. Much of his work was far in advance of his time, and hence we find his ideas still inspiring scientific research, his experimental discoveries still being transformed into great and growing industries. His views on the nature of electricity and magnetism, and on the correlation of the different forms of energy, foreshadowed in a remarkable way the results of later investigations; but, as Helmholtz said, "New

ideas need the more time for gaining general assent the more original they are, and the more power they have to change the broad path of human knowledge."

Faraday's gift of original thought was most conspicuous in his purely physical work, and except in the border-line region of electro-chemistry, his chemical discoveries were mainly the outcome of great experimental skill. Thus his discovery of benzene did not result from any previous train of reasoning or concatenation of ideas, but from brilliant technique. Though chemists and physicists may dispute possession of his scientific soul, we believe that he was a physicist *au fond*; his chemistry was not, however, the "dirty part of physics," in the words of Prof. Cohen's amusing quotation. It is quite probable that our successors will cease to regard chemistry and physics as separate sciences, and if they do, Faraday, before all others, will rank as the artificer of the union. "Talent may frolic and juggle, genius realises and adds," said Emerson, and Faraday's supernormal gifts of insight and experimental skill will always mark him out as one of the greatest master-builders of physical science.

To Faraday's character as a man, we have most eloquent tributes from Tyndall, Bence Jones, Gladstone, Dumas, and others. Actuated by a laudable if unscientific motive, biographers are apt to discard material which reflects adversely upon those whose lives they describe. In the case of Faraday they cannot lay themselves open to this imputation; his failings were extraordinarily few, and his real life was quite as beautiful as any romantic or hero-worshipping biographer could imagine it to have been. Except in the sphere of religious belief, Faraday and Huxley had many common traits. Each had a very strong sense of justice, and an unswerving respect for truth, to which was added an unquenchable enthusiasm for the verities of science. The lives of both were permeated by the highest moral purpose, and no one who tries to follow in their footsteps can but feel that great as were their contributions to natural knowledge, even greater were their characters as men.

Faraday as a Chemist.<sup>1</sup>

By Sir WILLIAM J. POPE, K.B.E., F.R.S., Professor of Chemistry, University of Cambridge.

MICHAEL FARADAY was born in 1791, as the son of a working blacksmith in London. During the distress of 1801, when corn rose to more than 9*l.* a quarter, his family received public relief, and one loaf of bread was allotted weekly to the nine-year-old child. His systematic education was rudimentary in character, for in his thirteenth year he became errand-boy to a bookseller in the neighbourhood of Manchester Square, and was entrusted with the duty of distributing the Sunday newspapers.

So lowly an introduction to life might seem to furnish but a slight foundation for a great scientific career. Yet Faraday became Director of the Laboratory of the Royal Institution in his thirty-fourth year, and succeeded Sir Humphry Davy in the chair of chemistry in 1827; on his death in 1867 he was mourned by practically every learned academy in the civilised world as one of the foremost of the great chemists and physicists of the first half of the nineteenth century. Many of Faraday's discoveries and much of his mode of interpreting chemical observations still persist as sources of inspiration to the chemist of a century later. The task of tracing the career of this great scientific luminary, of trying to decipher the stages in his major discoveries and of learning how his dominating position in science was attained, is an interesting one; it is also an illuminating one as showing how the exercise of industry and ability can reduce to negligible proportions the effect of faulty early education and of absence of family support.

Faraday was apprenticed as a bookbinder to his employer in 1805; his indentures note that "in consideration of his faithful service no premium is charged." He has told us that whilst an apprentice he read a great number of scientific books which came under his hands, and the correspondence which he left shows that he was in the habit of discussing with keen enthusiasm a large variety of scientific topics; he attended a few lectures on natural philosophy by certain private individuals who were in the habit a century ago of advertising such discourses. Early in 1812 a customer of his master's shop enabled him to attend four of Sir Humphry Davy's lectures in this theatre; we are told that he sat in the gallery just above the clock, and that he carefully elaborated his notes upon the experiments shown and the explanatory discourses. Faraday's contemporary correspondence makes it clear that he became captivated by the charm of manner and the skill in exposition and experiment of the master; he got into contact with Davy, and on

March 1, 1813, was appointed by the Managers as assistant in the Laboratory of the Royal Institution.

Faraday's scientific career had commenced, but it had commenced in circumstances which would have discouraged any but the most intrepid. The first piece of work in which he was called upon to assist Davy consisted in experiments on the newly discovered nitrogen chloride; six weeks after he came to the Royal Institution he was writing to a friend describing the injuries from which he and his master were suffering by the premature explosion of this capricious substance. Although this frequency of bodily hurt must have been very disconcerting to an entire novice in chemical experiment, Faraday seems to have accepted it without demur or complaint, and as a necessary incident to the occupation which he had now definitely determined to adopt. Indeed, a month later he writes his friend at some length, and with no little perspicacity, upon the conduct of lectures and the behaviour of lecturers. He observes that "polite company expect to be entertained not only by the subject of the lecture, but by the manner of the lecturer; they look for respect, for language consonant to their dignity, and ideas on a level with their own." This youth of twenty-one years of age was by no means unprecocious; he observes that "a lecturer should appear easy and collected, undaunted and unconcerned, his thoughts about him, and his mind clear and free for the contemplation and description of his subject."

In the autumn of 1813 Sir Humphry Davy left England for an extended tour through France, Italy, and Switzerland, taking Faraday with him as assistant and amanuensis. This journey, which lasted about eighteen months, appears to have been the only occasion on which Faraday left England for any length of time, and it undoubtedly exercised a great influence on his future life. The travellers carried chemical apparatus with them, visited a large number of foreign chemists, and themselves experimented on the novel problems laid before them. They experimented with the newly discovered element, iodine, with which Ampère provided them, and of course prepared the explosive nitrogen iodide; they visited Chevreul's laboratory, and attended a lecture by Gay-Lussac. Leaving Paris they drove across the Alps into Italy; at Genoa they studied the electrical discharge from the torpedo fish, and spent some time in Florence burning diamond with the aid of the great burning-glass in the Accademia del Cimento; they visited Vesuvius, made the acquaintance of Volta, and Faraday made copious notes on the firefly and the glow-worm.

<sup>1</sup> Discourse delivered at the Royal Institution on Friday, June 12.

They collected the natural inflammable gas at Pietra Mala, and identified it as methane in the laboratory of the Florentine Academy.

This lengthy journey, much of it in a country with which England was at war, must have been of inestimable benefit to Faraday; he acquired some acquaintance with the outside world, and the insularity and indeed petulance which he occasionally displayed in his letters concerning the manners and customs of people with whose language he was unacquainted, reveal his need for the wider experience thus afforded him. He saw the commanding position which Davy's genius as an experimental philosopher had acquired for him in European science, and, what was possibly of even more permanent importance, he had occasion to realise that the homage deservedly paid to his great master had led, perhaps, to some deterioration in those personal qualities which might be expected to accompany intellectual eminence.

In May 1815 Faraday recommenced work at the Royal Institution, and shortly afterwards took possession of living apartments in this building. It must be remembered that this period was one of extraordinary interest in connexion with chemical science. The sound experimental work of the previous century had freed the natural philosopher from the mystical and metaphysical trammels imposed by the alchemists, and had just led, through the work of Lavoisier, to an appreciation of the fact that quantitative measurements of weights and volumes had become the basis of an imminent great development in chemistry. Shortly before, Davy had overthrown Lavoisier's view that oxygen was the acid-forming element, had shown that hydrogen chloride contains no oxygen, and had proved that "oxymuriatic acid" was an elementary substance which he called chlorine; he had displaced caustic soda and caustic potash from their position as elements, and isolated from them the elementary metals sodium and potassium. Dalton had just enunciated the atomic theory, and Avogadro had stated his famous hypothesis that equal volumes of gases contain the same number of molecules under similar conditions of temperature and pressure; both these fundamental statements of principle were destined to survive to the present day as logical deductions from experimental observation. The next few years were to see the popularising of chemical science by the introduction of Davy's safety lamp for use in coal mines, an invention which was probably greater than any other asset in determining the increasing industrial activities of Great Britain.

This was the atmosphere in which Faraday found himself when he made his permanent home at the Royal Institution in 1815; his publications of the succeeding few years show that he occupied himself

busily in expanding his knowledge of science and in developing his remarkable talents as an experimenter.

Faraday's first contribution to chemical knowledge was a very modest one, and consisted in the examination of an Italian lime of volcanic origin; this was published in 1816, and was followed by some comments by Humphry Davy. His next essay was more ambitious. In 1816 the professor of mineralogy at Cambridge, E. D. Clarke, published a paper on the uses of the oxy-hydrogen blowpipe, an instrument which had been introduced by the American chemist, Robert Hare, in 1802. But whilst Hare fed hydrogen and oxygen separately into the blowpipe, Clarke proposed actually to use a mixture of the two gases in the requisite proportion; this involved the introduction of some device for preventing the flame from striking back and causing the explosion of the mixed gases in the reservoir. At this time Davy had perfected his safety lamp for use in the coal mines, and during this work had been led to reflect upon the various ways in which flame could be prevented from travelling through a body of inflammable gas; at Davy's suggestion Clarke caused the mixture of hydrogen and oxygen to pass through a short capillary of glass before entering the blowpipe. The explosion wave was extinguished by the cold walls of the capillary, and thus the risk of the explosion of the reservoir of gas was diminished; the risk was not entirely avoided, for Henry Gunning, in his "Reminiscences of Cambridge," notes the dangerous character of the oxy-hydrogen blowpipe as used by Prof. Clarke, who was a somewhat eccentric and superficial enthusiast. At all events, Clarke succeeded in volatilising gold and in burning diamond with his blowpipe, and in 1817 Faraday published a note describing the repetition and extension of Clarke's results; it will be recognised that no little experimental skill had to be exercised in order to avoid the occurrence of a disastrous explosion. Shortly after, Faraday described an apparatus in which Davy's experiment of burning diamond can be performed in an enclosed space; the diamond is carried in a platinum capsule suspended in a glass globe filled with oxygen, and a jet of hydrogen, ignited by an electric spark, is used to heat the diamond to its ignition temperature.

Faraday's earlier papers were of the nature of short notes, and were published in the *Quarterly Journal of Science*; this was the organ of the Royal Institution, and had been started by Brande in 1816. Faraday's first paper in the *Philosophical Transactions* of the Royal Society appeared in 1821, and described the discovery and properties of hexachloroethane,  $\text{CCl}_3 \cdot \text{CCl}_3$ , and its conversion into tetrachloroethylene,  $\text{CCl}_2 \cdot \text{CCl}_2$ . Six months later he described and analysed another

compound of carbon and chlorine, which Dr. Hugo Müller showed later to be hexachlorobenzene,  $C_6Cl_6$ ; by a curious coincidence Faraday thus had a simple derivative of benzene in his hands several years before he discovered benzene itself.

It is remarkable that in these papers, and in their author's other incursions into organic chemistry, no trace is found of a kind of mysticism which attended the treatment of carbon compounds almost until the middle of the nineteenth century. Lavoisier had shown that the majority of chemical substances produced as the result of animal or vegetable life contain carbon, and we still retain the name organic as descriptive of the carbon compounds. About 1760 the French naturalist, Buffon, stated that "there exists a living organic substance, universally distributed throughout all animal or vegetable substances, which serves equally for the nutrition, for the growth, and for the reproduction of animals and vegetables." Even in 1849 Berzelius wrote that "the elements seem to obey quite other laws in living nature than in inorganic nature; the products which result from the reciprocal action of the elements thus differ in the two cases. If we could succeed in learning the cause of this difference we should hold the key to the theory of organic chemistry; but this theory is so well hid that we have no hope of discovering it." The same idea of the existence of a vital force as provocative of chemical changes in living matter is common to these two writers, separated by nearly a century. The hexachloroethane and the tetrachloroethylene were typical organic compounds; they were produced from ethylene, which in turn had been prepared from alcohol obtained by the fermentation of sugar. It is characteristic of Faraday's broad outlook upon chemistry that he should have dealt with organic compounds as subject to the same laws as govern chemical substances in general; in this modernity of conception he anticipated many of his successors.

Whilst this work was in progress Faraday was engaged in an investigation of the alloys of steel in conjunction with James Stodart; this had for its object the improvement of steel intended for the manufacture of cutting instruments and the diminution of the tendency to rust. A large number of new alloys were prepared and studied; some, such as those with platinum, had little tendency to rust, those with rhodium could be forged and tempered, and the silver-steel alloys were used for some time for the manufacture of such articles as fenders. Although Faraday occasionally presented his friends with razors forged from certain of his new alloys, the work found no considerable technical applications; the modern extensive use of nickel-steel and chromium-steel, both of which Faraday

prepared, suggests that the work was in advance of the needs of the times.

Another piece of work undertaken in 1822 led to results of far-reaching importance. Humphry Davy had shown that the supposed solid chlorine obtained by cooling moist chlorine is really a hydrate of this element; Faraday determined the composition of this unstable compound as, roughly,  $Cl_2 \cdot 10H_2O$ , but the exact composition is not yet known. On sealing the substance up in an inverted V-shaped tube, and warming the arm containing the chlorine hydrate, Faraday observed that chlorine was given off, and became condensed to a yellow liquid in the empty arm; the hydrate had decomposed and the evolved chlorine had been liquefied by the pressure set up during its liberation. On cooling the arm containing the liquid chlorine to  $0^\circ C.$  and then opening the tube, part of the chlorine boiled off and the remainder became, in consequence, so cooled that it remained liquid under atmospheric pressure. Faraday estimated that the temperature so attained must have been lower than  $-47^\circ F.$ , and, as we now know, it is about  $-47^\circ F.$  He also found that chlorine could be liquefied at ordinary temperatures by four or five atmospheres pressure. The novel device of liquefying a gas by taking advantage of the pressure set up in a closed vessel by liberating the gas in a closed vessel, was clearly capable of wide application, and its inventor immediately used it for the liquefaction of sulphur dioxide, hydrogen sulphide, chlorine dioxide, nitrous oxide, cyanogen, ammonia, and hydrogen chloride. His interest in the subject aroused, he proceeded to liquefy a number of more refractory gases by cooling them under pressure in a bath of solid carbon dioxide and ether, and also succeeded in converting hydrogen bromide, hydrogen iodide, sulphur dioxide, hydrogen sulphide, nitrous oxide, ammonia, and other gases into crystalline solids. The systematic study of the liquefaction of gases initiated by Faraday provided the foundation for much of the most brilliant work done within these walls by another great experimental genius, the late Sir James Dewar.

We now arrive, in this brief survey of Faraday's chemical work, at the moment of that important discovery which laid the foundation of more than one-half of modern organic chemistry and of one of the most important branches of chemical industry; this was the discovery of benzene, which was announced to the Royal Society on June 16, 1825.

Early in the last century the Portable Gas Company was engaged in making illuminating gas by dropping whale or cod oil into a furnace maintained at a red heat; the inflammable gas produced by this process of destructive distillation was subjected to a pressure

of about thirty atmospheres and stored in portable vessels. These latter were then transported to private houses and other buildings, and the gaseous contents burnt for illuminating purposes. During the process of compression a liquid was deposited, each 1000 cubic feet of gas yielding nearly a gallon of this oil. Faraday subjected this condensed liquid to careful examination, and separated from it a compound of carbon and hydrogen which he termed bicarburet of hydrogen; he made a detailed study of this substance, and the analytical results which he obtained, translated into the modern nomenclature, give its molecular composition as  $C_6H_6$ .

The memoir in which Faraday describes the isolation of this hydrocarbon is written in very simple language, but it reveals throughout the handiwork of a genius in experimentation, and of an unrivalled master in the interpretation of experimental results. Thus, at this early date, and with the very modest appliances at his hand, the experimenter separated benzene in a state of purity from a very complex mixture; he found that it solidified on cooling, and gave its melting-point as  $5.5^\circ C.$ , the correct melting-point being  $5.44^\circ$ . He determined the composition of the hydrocarbon by a method so ingenious that it might well tax the skill of the modern worker. He evaporated the hydrocarbon into a known volume of oxygen, noted the increase in gaseous volume, exploded the mixture in the eudiometer and noted the diminution in volume, then treated it with caustic potash solution and observed the further diminution in volume due to the removal of the carbon dioxide. The data thus obtained give the proportion of carbon to hydrogen, and also the density of benzene vapour as compared with hydrogen as the standard; Faraday hence calculated the vapour density as 39, which is the correct value.

This exhibition of real mathematical power as a mode of unravelling a complicated skein of quantitative data was followed by a profound study of the chemical behaviour of the new substance. Faraday noted that chlorine is without action on benzene in the absence of sunlight, but that when the mixture is exposed to sunlight, vigorous action occurs with evolution of hydrogen chloride; he succeeded in separating the solid chlorination product, obviously *p*-dichlorobenzene, from the liquid residue containing the *o*-isomeride. This was the first occasion on which the catalytic activity of sunlight in promoting the action of halogens on the aromatic hydrocarbons had been observed, and it is perhaps superfluous to remark that this particular aspect of catalytic activity is still growing in importance and is still a subject for scientific study.

Many other points in this memoir of Faraday's might well call for distinction, but it will suffice to recall the

comment passed upon the paper by Berzelius: "One of the most important chemical investigations which has enriched chemistry during 1825 is without doubt that of Faraday on the oily compounds of carbon and hydrogen obtained by compressing the gases obtained by the decomposition of fatty oils." The great Swedish chemist, himself the intellectual giant of the quantitative chemistry of his day, was impressed less by the new facts recorded than by the consummate art exercised in their elicitation and by the conviction that a new epoch had dawned in organic chemistry.

The bicarburet of hydrogen which Faraday separated from the gas obtained by the destructive heating of an animal oil was prepared by an entirely different means some ten years later. Mitscherlich obtained it in 1834 by distilling benzoic acid with lime, and proposed to give it the name benzin because of its relation to benzoic acid, which in turn derived its name from its original source, gum benzoin; Liebig objected to this name and proposed that it should be named benzol. Liebig's statement, made in 1834, that benzol could be obtained from coal, is possibly based on a misreading of Faraday's paper in which he states that he had not been able to obtain it from coal-tar. The presence of benzol in coal-tar seems to have been first noted by John Leigh in 1824, and this observation was confirmed by Hofmann in 1845; in 1849 Mansfield was manufacturing benzol on a factory scale from coal-tar, and indeed lost his life in 1856 as the result of a fire which occurred whilst he was preparing the compound. The name benzol still survives as descriptive of the technical product, but the chemical name of the substance has now become benzene.

Benzene is the first member of a long series of compounds of carbon and hydrogen, the so-called aromatic hydrocarbons, which are closely related in chemical constitution and chemical behaviour. The second member of the series is toluene,  $C_7H_8$ , which was discovered by Pelletier and Walter in 1837, and is also separated in large quantities from coal-tar. Before discussing the modern importance of this particular series of aromatic hydrocarbons, it may be well to refer to others with which Faraday was closely associated.

The hydrocarbon naphthalene was observed as a crystalline deposit in an apparatus used by Garden in 1819 for the distillation of coal-tar; its separation from coal-tar was described by John Kidd, the professor of chemistry at Oxford, in January 1820. The chemical composition of naphthalene was determined by Faraday early in 1826; Faraday prepared the two isomeric derivatives, now known as the naphthalene  $\alpha$ - and  $\beta$ -sulphonic acids, and contributed further particulars concerning the behaviour of this hydrocarbon. The interest aroused in the components of coal-tar by Faraday's

remarkable work on benzene and naphthalene led to a rapid increase in our knowledge of the composition of this raw material. In 1832 Dumas and Laurent separated anthracene from it, and, up to the present time, some thirty aromatic hydrocarbons, and more than that number of other aromatic compounds, have been extracted from this product of the distillation of coal.

It is worth while, if merely as an object-lesson exhibiting the vast influence which can be exerted on the world's affairs by some originally modest piece of scientific research, to consider the scope and magnitude of the progress made as a result of Faraday's discovery of benzene one hundred years ago.

The whole of the great coal-tar colour industry sprang from Faraday's study of coal-tar. In 1856 the late Sir W. H. Perkin made the first coal-tar colour, Perkin's Mauve, from coal-tar benzene; and at the great Exhibition of 1862 a large number of such artificial colouring matters were displayed. So rapid had been the progress made during half-a-dozen years that in 1862 Hofmann was able to write as follows concerning benzene:

"For years the newly discovered compound could claim scientific interest only. In this investigation, as indeed throughout the whole series of his immortal researches, Faraday's object was the elaboration of truth for its own intrinsic value and beauty; and in the same spirit has the work been continued by those who, after Faraday, engaged in the further scientific examination of the subject. Nobody, in those early days of benzol, when the substance simply existed as a laboratory curiosity, dreamed of the brilliant career looming in the distance for this body, nor of the marvellous transformations it was destined to undergo."

Since the early days when Hofmann was moved to use these words, the development of coal-tar colour manufacture has proceeded with progressive rapidity; the number of coal-tar colours now recognised as of technical value is of the order of 1200. Whilst the earlier artificial dyestuffs, although brilliant in colour, were often fugitive to light or to washing, we are now in possession of coal-tar colours which are more fast to light and to washing than indigo, madder, or any of the stable dyestuffs known to our ancestors. Many of the newer aromatic artificial dyes persist even when the fabric on which they are deposited has rotted away. The late Lord Playfair, and many other chemists, saw that the coal-tar colour industry was likely to influence in a remarkable manner the industrial fortunes of Great Britain. Hofmann put this view forward in 1862 in a remarkable passage:

"For, if coal be destined sooner or later to supersede, as the primary source of colour, all the costly dyewoods hitherto consumed in the ornamentation of textile fabrics; if this singular chemical revolution, so far from being at all remote, is at this moment in the very act and process of gradual accomplishment—are we not on the eve of profound modifications in the commercial relations between the great colour-consuming and colour-producing regions of the globe? Event-

ualities, which it would be presumptuous to predict as certain, it may be permissible to forecast as probable; and there is fair reason to believe it probable that, before the period of another decennial Exhibition shall arrive, England will have learned to depend, for the materials of the colours she so largely employs, mainly, if not wholly, on her fossil stores. Indeed, to the chemical mind it cannot be doubtful that in the coal beneath her feet lie waiting to be drawn forth, even as the statue lies waiting in the quarry, the fossil equivalents of the long series of costly dye materials for which she has hitherto remained the tributary of foreign climes. Instead of disbursing her annual millions for these substances, England will, beyond question, at no distant date become herself the greatest colour-producing country in the world; nay, by the strangest of revolutions, she may ere long send her coal-derived blues to indigo-growing India, her tar-distilled crimsons to cochineal-producing Mexico, and her fossil substitutes for quercitron and safflower to China, Japan, and the other countries whence these articles are now derived."

This pronouncement of Hofmann is interesting in that it involves two propositions, one correct and the other incorrect. The instinct and wide experience of the chemist told him, and told him correctly, that the coal-tar dyes were destined largely to replace the vegetable colouring matters and to provide the textile manufacturer with increased opportunities for the production of new effects; but when he took for granted that the new discovery would find vigorous commercial development in the country of its birth he was forming an opinion on a subject less his own than chemical science. Within a few years Great Britain was exporting coal-tar to Germany for dyestuff manufacture, and, whilst artificial colour manufacture languished here, Germany forged ahead and soon dominated all others in the new industry. Indigo-planting and indigo preparation did indeed dwindle into insignificance, largely because no concerted effort was made to apply scientific methods to the improvement of methods which had remained unchanged for perhaps a thousand years; but it was Germany which exported artificial or coal-tar indigo to India and not Great Britain.

It has just been hinted that scientific cultivation and scientific methods of separation might have enabled natural indigo to hold its own against artificial indigo produced from the components of coal-tar; there is indeed solid foundation for the belief that natural indigo, had its production not been woefully mismanaged, would never have been supplanted by the artificial material. It would appear likely that the percentage of colouring matter yielded by the indigo plant might be greatly increased by scientific breeding and by improved methods of extracting the colour; the percentage of sugar obtained from the sugar beet by judicious selection of seed and careful development of methods of extraction was raised from little more than 5 per cent. to about 20 per cent. on the weight of the

beet. Furthermore, and for reasons which need not now be discussed, it seems clear that natural indigo is of distinctly greater value as a dyestuff than the artificial product. These facts were realised by the Government of India many years ago: a scheme of research work was launched, financed by the State, and notable advances were made in the manufacture of natural indigo. But at the moment when it had become clear that indigo planting could be given a new and profitable lease of life, the Indian Government, apparently from motives of economy, abandoned the research scheme; the considerable expenditure of money which had been incurred thus represented, for all practical purposes, an extravagant waste of money. It seems at first sight irrational to spend a large sum of money in proving the truth of a scientific forecast as to how a particular scientific industry can be made to flourish and to abandon the project at the moment of fructification; at the same time, the fact that this remarkable method of procedure is the standard method adopted by British Governments would suggest that it has a sound economic basis.

Whilst little or nothing was done to stimulate the cheap production of natural indigo, neither effort nor money was spared in the attempt to manufacture coal-tar indigo in the German colour works; it has been stated that 2,000,000*l.* was spent on chemical research and technical development before synthetic indigo was put upon the market. The vast amount of chemical and technical experience gained during this great enterprise did not lead to the production of indigo alone; many compounds closely allied to indigo and possessing value as dyestuffs were also made. Included among these is the traditional Tyrian purple, which is contained in the secretions of a small marine snail.

Again, the competition amongst coal-tar dyestuff manufacturers led to new developments in connexion with the manufacture of entirely novel dyes of like stability to indigo, although belonging to entirely different classes of chemical compounds. Many of these, grouped together as the so-called "vat-dye-stuffs," are derivatives of the hydrocarbon anthracene which has been previously mentioned; they can be produced from anthracene separated from coal-tar. But coal-tar anthracene is costly, whilst the two hydrocarbons with which Faraday was so closely associated, benzene and naphthalene, can be extracted from coal-tar in large quantities at but little expense. As an illustration of the thoroughness with which chemical skill has been applied to the solution of the economic problems which arise in the manufacture of artificial colouring matters may be quoted the fact that the cheap raw materials, benzene and naphthalene, can

now be used instead of anthracene itself in the manufacture of the dyestuffs relating to anthracene. Naphthalene can be partially burnt in the air so as to yield phthalic acid; this phthalic acid can be caused to condense with benzene to give anthraquinone. The anthraquinone thus manufactured can be used to replace that previously obtained from the costly anthracene, and can be utilised in the manufacture of the better-class vat-dyestuffs.

Whilst the manufacture of coal-tar dyes grew to vast dimensions owing to wise development and exploitation, other industries and fields of knowledge also benefited. In course of time it was found that Faraday's benzene was the starting material for many aromatic substances of use in medicine, in photography and in many other arts. Furthermore, the coal-tar hydrocarbons, benzene and toluene, are the raw materials from which the high explosives, picric acid and trinitrotoluene, are manufactured. At the outbreak of the War, no picric acid was being made from benzene, and no trinitrotoluene had ever been made on a large scale in Great Britain. This was of course well realised on the Continent; to what extent the known unpreparedness of Great Britain for the manufacture of the staple high explosives was a factor in precipitating war cannot now be ascertained.

The set of great industries involved in the manufacture of artificial dyestuffs, pharmaceutical products, and military and naval high explosives are thus closely allied. Faraday's discovery of benzene and its analogues is also important in connexion with liquid fuel used in the ordinary internal combustion engine. Certain of the naturally occurring petroleum contain large proportions of aromatic hydrocarbons, such as benzene, and the fact that a petroleum from Borneo, containing about 20 per cent. of benzene and toluene, was available in 1914, was a very material relief to the difficult situation created by the impossibility of immediately preparing large quantities of raw materials from coal-tar for the manufacture of high explosives. Benzene and toluene from coal-tar are now largely used for blending with petrol from overseas and for improving its efficiency as a fuel.

In the year 1825 Faraday undertook, at the request of the Council of the Royal Society, a lengthy and laborious experimental study of the manufacture of optical glass; the investigation extended over four years, and was fruitful in that it provided a great deal of accurate and precise data as to the conditions to be desired or to be avoided in the making of glass for optical instruments. The notable positive result of the work was the discovery of the so-called heavy glass, which consists largely of a lead borosilicate and has very high refractive power. The expenses incurred in

carrying out this work were amongst the objects of a violent attack levelled against the president and Council of the Royal Society in 1830 by Sir James South. The "heavy glass" was destined later to serve in Faraday's discovery in 1845 of the rotation of the plane of polarisation of light when passed through a transparent medium in a strong magnetic field; this property, that of magnetic rotatory power, took its place amongst the important physical constants of chemical substances as a result of the work of the late Sir W. H. Perkin.

Yet another brilliant piece of Faraday's experimental chemical work remains to be mentioned. He had noted that films of beaten gold of some  $1/280,000$ th of an inch in thickness are translucent, and that the transmitted light is green in colour; from this observation he was led to study the transmitted colour of still thinner films of gold and other metals, and to the conclusion that glass, fused with the addition of a trace of a gold salt, owes its ruby colour to the diffusion throughout the mass of minutely divided gold. The reduction of metallic gold in aqueous solution also engaged his attention, and he concluded that the bright red-coloured solutions thus obtained owed their colour to the diffusion of minute particles of metallic gold throughout the liquid. These coloured and apparent solutions of metallic gold in water are very stable; their study by Faraday in 1857 was an obvious prelude to the classical studies of colloidal solutions published by Thomas Graham, the Master of the Mint, in 1861.

So far I have dwelt, perhaps with too much insistence, on Faraday's pre-eminence as an experimenter, and, possibly again in too accentuated a manner, with the world-extended influence of his chemical work on the subsequent history of our planet. Such possible defects call for an apology. Faraday came forward as an experimental genius at a time when the chemist was forced to work with the aid only of ordinary domestic appliances, and when he had to make for himself every item of the apparatus which he desired to use. His "Chemical Manipulation," published in 1829, provides a fund of information concerning details of chemical experimentation of which the chemical student of to-day is entirely ignorant. We have progressed so far in our experimental study of chemical phenomena that the investigator is now but little dependent on his own manipulative skill, and has become largely subservient to the ingenuity of the scientific instrument maker. Again, an apparently non-utilitarian experimental discovery made in one generation seems naturally to become the corner-stone of some gigantic industrial development in the next decade. A perusal of Faraday's experimental work furnishes ample material in support of this thesis; and, to come nearer to the present day, many of those present to-night had the privilege of

witnessing those fundamental experiments on the liquefaction of gases, shown in this theatre by Sir James Dewar, which have become the foundation of great industries.

It would be a mistake to attempt to measure the achievements of Faraday on a scale derived from a consideration of the immediate material benefits to the world which have accrued from his work. Probably no man, with the possible exception of Newton, has ever exercised throughout a century such a persistent directive impulse to the activities of a huge body of scientific workers. This is the more strange in that Faraday was essentially a solitary worker; the long list of his published papers includes but two in which he is named as a joint author. It would almost seem that the man was endowed with such consummate skill as an experimenter that any collaborator of his day would have impeded the progress of a joint investigation. It might perhaps have been anticipated that one so much accustomed to work alone, and as a pioneer far ahead of most of his contemporaries, would have tended towards narrow specialisation and have gradually lost interest in other branches of scientific activity by reason of intense cultivation of his own field of investigation. Some justification for such an expectation may be sought in the fact that although he was the first secretary of the Athenæum Club, he resigned the position after one year of office, and that he declined nomination to the presidency of the Royal Society on the ground that it would impede his experimental work. But the lengthy correspondence of Faraday with Schönbein, Liebig, Whewell, Wheatstone, Agassiz, Dumas, Wollaston, Herschel, de la Rive, Gay-Lussac, and a host of other great contemporaneous scientific men, shows that his interests were widespread, and that he bore always in mind his primary concern for the advancement of natural philosophy as a whole. One of the most acute judges of his fellow-men, the Count Camillo Cavour, records an appreciation which is worthy of quotation; he found Faraday "without a waistcoat, in a ragged old coat, looking for all the world like a sixteenth-century savant. But one can see that he has great rapidity of perception and quickness of decision—two qualities which lead almost instinctively to these great discoveries. There is not a scrap of scientific conceit about him."

In this conservation of a wide scientific interest, so difficult for an isolated worker, the nature of Faraday's duties in the Royal Institution must have played a great part. One of his major tasks consisted in expounding the results of current scientific progress to a cultured, though not a specialist audience; his sense of responsibility towards that audience led him so to train his powers that he became the most efficient popular

exponent of science of his day. His lectures to children on the chemical history of a candle show that he was an unrivalled master of lucidity of exposition and a genius in the device of simple but convincing illustrations.

It must not, however, be imagined that Faraday confined himself to the discovery and exact statement of experimental facts without thought for their theoretical significance. His respect for a bold and far-reaching generalisation, put forward as a mathematical interpretation of facts—and this is what is meant by a theory—is expressed in many of his writings. He begins one of his papers with the following passage :

" That wonderful production of the human mind, the undulatory theory of light, with the phenomena for which it strives to account, seems to me, who am only an experimentalist, to stand midway between what we may conceive to be the coarser mechanical actions of matter, with their explanatory philosophy, and that other branch which includes, or should include, the physical idea of forces acting at a distance, and admitting for the time the existence of the ether, I have often struggled to perceive how far that medium might account for or mingle with such actions generally, and to what extent experimental trials might be devised, which, with their results and consequences, might contradict, confirm, enlarge, or modify the ideas we form of it, always with the hope that the corrected or instructed idea would approach more and more to the truth of nature, and in the fulness of time coincide with it."

The literature of science may be searched in vain for a more sympathetic and a more accurate definition of the relation which should exist between the pure experimenter and the mathematical interpreter of the observed facts: and because Faraday was both. Clerk Maxwell, who was the first to translate Faraday's brilliant conceptions into mathematical language, and to apply to them all the powerful methods of the mathematical workshop, observed that :

" The way in which Faraday made use of his idea of lines of force, shows him to have been in reality a mathematician of a very high order—one from whom the mathematicians of the future may derive valuable and fertile methods."

This is the deliberate opinion of one who was not given to exaggeration, and who, in the course of a short life, contributed more perhaps than any other to the development of mathematical physics in the Victorian period. That Clerk Maxwell's judgment was sound is obvious to all who have had occasion to study the remarkable series of experimental researches in electricity published by Faraday between 1831 and 1860; early in these classical investigations Faraday succeeded in forming very clear ideas concerning the manner in which an electric current operates in the decomposition of water or of salts in solution. He showed that when water is electrolysed the quantity decomposed is exactly proportional to the quantity of electric energy which has passed, and that the products of the decomposition can be collected and measured " with such accuracy as to

afford a very excellent and valuable measurer of the electricity concerned in their evolution." He showed further that in all cases the quantity of chemical decomposition is exactly proportional to the quantity of electricity which has passed through the electrolyte, and that a given quantity of electric energy liberates chemically equivalent amounts of the metals during the electrolysis of metallic salts. In this way Faraday was able to determine a series of numbers representing the electrochemical equivalent of the elements, and to show that the electrochemical equivalent is the same as the chemical equivalent. It remained for a later worker, Sir Edward Frankland, to formulate the conception of valency, to point out that the true atomic weight of an element, divided by the valency, gives the chemical equivalent, and so to pave the way for securing the atomic theory in its present impregnable position. The work of Faraday on electrolysis was one of the essential steps taken during the nineteenth century to realise what Newton foresaw when he remarked :

" It seems probable to me that God in the beginning formed matter in solid, massy, hard, impenetrable movable particles, of such sizes and figures, and with such other properties, and in such proportion to space, as must conduce to the end for which He formed them; and that these primitive particles, being solids, are incomparably harder than any porous body compounded of them, even so hard as never to wear or break in pieces; no ordinary power being able to divide what God Himself made one in the first creation."

But still more far-reaching consequences resulted from Faraday's electrochemical work; he often expressed his conviction that the forces termed chemical affinity and electricity are one and the same, and he had been led to associate a definite quantity of electricity with the liberation of the atomic unit of an element from combination. There must thus exist a definite minimum unit of electricity; and, as Helmholtz indicated more definitely in 1880, not only matter but also electricity itself has an atomic structure. The discoveries of the last thirty years, which have resulted in the isolation of the atom of negative electricity—the electron—and the identification of the atom of positive electricity with the positively charged hydrogen atom, are the logical outcome of the work of Faraday.

To the chemist the discussion, applications, and extension of Faraday's electrochemical conceptions have been a fruitful source of inspiration and progress for nearly a century; as time passes on, those conceptions are seen to increase continually in fundamental significance. It cannot be doubted that when the second centenary of the discovery of benzene is honoured in this theatre a hundred years hence, my successor will be able to point to consequences still more fundamental and far-reaching, of the work and thought of perhaps the greatest experimental genius the world has ever seen.

The Faraday Benzene Centenary.<sup>1</sup>

By Prof. HENRY E. ARMSTRONG, F.R.S.

**A**N indescribable feeling of deepest reverence thrills those who know that they are within a holy of holies when standing at this table whence Davy and Faraday and Dewar disclosed their discoveries to the world.

Consider the immensity of outlook it commands. A few days ago, the glories of Tut-ankh-Amen's most wonderful tomb were depicted, in minute detail, upon the screen behind me. We could realise that man stood higher, in the decorative arts, several thousand years ago, than he does to-day—that man was then deeply reverent in his beliefs. In stark contrast is the change in our civilisation—we call it advance—made within the past century, through the application of the discoveries discoursed of within these walls: in large measure fired by the tiny spark first shown to the world, at this table, in 1831. What reverence have we for such a discovery? Our men of letters pay no heed to it. The public at large has no knowledge thereof.

Chemists desire to show, by this commemoration, that they are persons mindful of the words of the ancient poet and preacher:

Let us now praise famous men  
And our fathers that begat us.  
The Lord hath wrought great glory by them  
Through His great power from the beginning.  
Such as did bear in their kingdoms,  
Men renowned for their power,  
Giving counsel by their understanding  
And declaring prophecies:  
Leaders of the people by their counsels  
And by their knowledge of learning meet for the  
people,  
Wise and eloquent in their instructions.

"Of them that have left a name behind them," Faraday is one of the greatest, certainly the greatest experimental philosopher the world has yet known. A Sandemanian, deeply religious, from his childhood upwards, throughout life, he advisedly kept his "science"

apart from his religion but his moral faith was ever the background of his scientific productivity. His work was all conceived and executed in a deeply religious spirit. It will only be by following his example that wisdom will be made the religion of the people. He painted himself, his attitude during the whole of his career, in a lecture he gave in 1816, when only twenty-five years old, in saying—

"The philosopher should be a man willing to listen to every suggestion but determined to judge for himself. He should not be biassed by appearances; have no favourite hypothesis; be of no school and in doctrine have no master. He should not be a respecter of persons but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of nature."

Speaking at this table, in May 1854, addressing His Royal Highness, the Prince Consort, who occupied the chair, Faraday said: "I take courage, Sir, from your presence here this day, to speak boldly that which is on my mind." The lecture was on "Mental Education." In it he dealt with the need of self-education, through attention to "natural things," with the object of improving the faculty of judgment and making it proportionate.

"I will simply express my strong belief," he said, "that that point of self-education which consists in teaching the mind to resist its desires and inclinations, until they are proved to be right, is the most important of all, not only in things of natural philosophy but in every department of daily life."

The lecture was a profession of the attitude of mind in which he had accomplished his work.

Taking courage to speak boldly, in the presence of your Grace, I would say that even the world of science, to-day, is in great need of following counsel such as Faraday gave in his incomparable lecture. We are too prone to speculate—often too inconsiderate in speculation—too little alive to our own individual ignorance—

<sup>1</sup> Address delivered at the Royal Institution on June 16, the Duke of Northumberland in the chair, at the celebration of the centenary of the discovery of benzene by Faraday.

too little bent upon cultivating that breadth of vision and proportionate judgment which is at the root of scientific method. Overcome by the ecstasy of practical achievement, we are too little mindful of the public interest: we are doing too little to make scientific method a public possession. Faraday's dream is in no way fulfilled: the spirit of science in no way enters into our commerce, into our industry, into our public life.

Our best way to praise famous men is to take to heart the lessons of their lives. Consider what Faraday did, at this table, to accomplish the exhortation—"Suffer little children to come unto me." He introduced the Children's Christmas courses and in all his lectures endeavoured to come down to the level of his hearers. How different this from our modern practice—our entirely selfish use of jargon.

We seek to-day to direct attention to Faraday's special greatness as a chemist. He is generally thought of in connexion with electrical discovery but it is significant that he began his career as a chemist: that he grew up in the severity of a proper chemical discipline: just at the time, however, when electricity was coming into vogue. Inspired by his great master, Humphry Davy, fascinated by the wonderful use Davy had made of the electric current in liberating the alkali metals and in discovering the nature of so common a substance as lime, gifted with marvellous power of insight and unhampered by the mass of detail which encumbers our modern thought, he could not do otherwise than recognise the reciprocal inseparable nature of chemical and electrical phenomena. He ultimately proclaimed the essential unity of chemical and electrical change—not yet generally recognised by chemists, though in these days even matter is regarded as of electrical origin. We have yet to acknowledge Faraday's prescience and the consequences of this, his prime discovery.

The range of his chemical activity is astounding, the more when we consider his slender equipment and the fact that he did almost everything himself. As one of the earliest workers in organic chemistry, he stands pre-eminent. He not only discovered the hydrocarbon benzene but also three of the five chlorides of carbon; moreover he was the first to study the sulphonic acids, a class of compound now of the first technical importance. His achievement in making these acids was akin, in principle, to that by which Montgolfier's balloon was changed into the air-ship of to-day, by the introduction, into the car, of the internal combustion engine with its propeller. Naphthalene is an unwieldy hydrocarbon which floats upon water but cannot swim in it, being insoluble—Faraday, by introducing the ele-

ments of sulphuric acid, made it soluble and mobile. The discovery has been of infinite service in the dye-stuff industry. Faraday was one of the first to examine caoutchouc. His name is associated, for all time, with the liquefaction of the gases. He also studied alloys of iron, optical glass and gold in the finely divided state—each an inquiry of major consequence. Many minor issues were examined, always with perspicacity.

The discovery upon which we base this commemoration, that of benzene, will always rank as one of the most fundamental discoveries of chemistry. If not the entire hub of the organic section of our chemical universe, benzene is at least a major part thereof. Our edifice, in fact, has two foundation stones: one, the simple carbon atom, which can be extended endlessly, as links are, in a chain; the other, a closed complex unit or block of six carbon atoms, ranged as in the diamond and associated symmetrically with six atoms of hydrogen. This latter we call benzene. It is, in fact, just a bit of diamond, mounted and preserved in hydrogen, as though this were *aspic*. The beauty of the diamond, however, is as nothing compared with that of benzene in the eyes of its many mistresses.

Faraday separated benzene from the products of the decomposition of oil by heat. He seems to have taken an interest in these products so early as 1818 but did not come into possession of the material for their study until April 26, 1825. Beginning the investigation on this date, he soon isolated benzene and may be said to have discovered it on May 24, the day on which he first determined its composition, by an operation itself a wonderful experimental "tour de force"; the memoir in which he submitted his discovery to the Royal Society is dated June 16. Having studied a material such as he used and knowing its complexity, I marvel at the rapidity with which he carried out the inquiry and the accuracy of his deductions. It is a work of astounding genius.

In those days, formulæ were scarce known. Dalton had but recently put forward his atomic theory. Faraday, however, was already alive to their use and called his product bicarburetted hydrogen,  $C_2H$ , the value then assigned to carbon being half the present value. He gives the data for the molecular formula,  $C_6H_6$ , though molecular formulæ were unthought of then. About ten years later, the hydrocarbon was prepared from benzoic acid, by Mitscherlich, who altered the name to *benzin*, which Liebig changed to *benzol*. Later (1834), the systematist Laurent introduced the use of the terminal *ene* (ène); alternatively, he proposed the name *phène* (from *φαίνω*, to shine), whence phenyl.

The classic academic event in the history of benzene

was the introduction by Kekulé, in 1860, of the conception of a closed system of carbon atoms typified by the world-renowned hexagonal formula. He has told us how the idea first came to him when going home to his lodgings on the top of a London bus. Since then, benzene and its derivatives have been the subject matter of a vast volume of inquiry by all the nations: German chemists, however, were long the leaders.

Attention was first specially directed to the presence of benzene in coal tar in 1845. The process of extracting it was devised, in 1849, by Mansfield, working in Hofmann's laboratory in Oxford Street, London. To-day, the gases formed on heating coal to redness, either in manufacturing town's gas or metallurgical coke, are most carefully stripped of benzene and allied hydrocarbons. Our output of "crude benzol" is estimated at 22,000,000 gallons, which is mostly used as motor fuel. Certain petroleum products contain considerable quantities of benzene hydrocarbons.

Benzene only acquired technical importance from 1856 onwards, when our countryman, William Henry Perkin, entered upon his great adventure, at the age of nineteen. He not only discovered the first aniline colour, mauve: he also founded the artificial dyestuff industry. To-day, the natural colouring matters are all but displaced by dyestuffs, often superior, derived more or less directly from benzene.

Nothing that has happened since Faraday made his discovery would have given the philosopher greater pleasure than the advance in our knowledge of the origin of colour—a subject which once filled his mind. Turning to his remarkable correspondence with the Swiss chemist, Schönbein, whose name comes next to those of Priestley and Lavoisier in the history of oxygen, we find Schönbein, in a letter dated Oct. 17, 1852, writing to him as follows:—

"Entertaining the notion that in many, if not in all cases, the colour exhibited by oxycompounds is due to the oxygen contained in them or, to express myself more distinctly, to a peculiar chemical condition of that body, I have continued my researches on the subject and obtained a number of results which I do not hesitate to call highly curious and striking. . . . I am nearly sure that you will be pleased to repeat the experiments, for either by mere physical means or by chemical ones you may make and unmake or change the colour of a certain substance without altering the chemical constitution of those matters. To my opinion, that wonder is performed by changing the chemical condition of the oxygen of the oxycompound."

To this Faraday replied on December 8:—

"Your letter quite excites me and I trust you will establish undeniably your point. It would be a great thing to trace the state of combined oxygen by the colour of its compound, not only because it would

show that the oxygen had a special state, which could in the compound produce a special result—but also because it would, as you say, make the optical effect come within the category of scientific appliances and serve the purpose of a philosophic induction and means of research, whereas it is now simply a thing to be looked at. Believing that there is nothing superfluous or deficient or accidental or indifferent in nature, I agree with you in believing that colour is essentially connected with the physical condition and nature of the body possessing it and you will be doing a very great service to philosophy if you give us a hint, however small it may seem at first, in the development or, as I may even say, in the perception of this connexion."

Before you are two specimens, one of quinol, the other of quinone, one colourless, the other coloured—yellow. Quinone is the type of all organic colouring matters. In quinol, the simple molecule of water,  $H \cdot O \cdot H$ , less an atom of hydrogen, is introduced twice into benzene, in place of two of its atoms of hydrogen: it is colourless. Remove from it two atoms of hydrogen, one from each of the two OH groups: the product, quinone, is yellow in colour. It is as Faraday supposed—the condition of the oxygen is altered and certain centres in the molecule become active absorbents of the light waves.

I have ventured to hang upon the inward wall of this great fortress of science, which Faraday occupied to such wonderful purpose, "a banner sable, trimmed with rich expense," bearing a strange device emblematic of benzene. Faraday's initial is enclosed within the hexagon which symbolises his discovery. This symbol is one that we may aver will last for all time, as upon it may be welded all the facts relating to benzene. It is probably the most significant symbol ever devised, for it has veritable volumes of meaning in the chemist's seeing eye. From it the colours irradiate—though not precisely in prismatic order. Colour, at its first appearance, is either yellow or blue, according to the type of compound, yellow being always associated with simplicity of type. As molecular complexity is raised, yellow is gradually intensified and passes into the richest red. Blue, in like manner, becomes intensified and may pass into green, which is the forerunner of black. The changes are due either to changes in the weighting of the absorbing centres or to their cumulative repetition and co-operative action.

Behind me is a curtain of wondrous texture and colour, dyed with *Jade green*, one of the latest and most valuable, certainly the most remarkable of the anthracene vat-colours: it was first made in Scotland. Mark its symbol—it is benzene soldered upon benzene, many times over: a *Nonaphene*. The two lone, unsociable, oxygen atoms are the main cause of its colour. Note the wonderful change in colour when these oxygen

atoms are wedded each to an atom of hydrogen—now the *Jade green* becomes a salmon-red, with a most remarkable fluorescent sheen, indicating a simplification of the light-absorbing mechanism. The big hank of viscose silk across the green curtain is dyed with the material in which the green has been thus wedded hydrogen: if oxygen be allowed to take away the hydrogen, the dyestuff again becomes green, may we not say, with envy. Note also this intensely blue hank. In *Jade green* the oxygen atoms are related as are my thumbs when I so juxtapose my fingers that the backs of my two hands are in the same plane. Turning one hand round, my thumbs become related diagonally. Making a like change in the molecule of *Jade green*, converting the dibenzanthrone into isodibenzanthrone, the colour passes into blue: wed the oxygen with hydrogen, it passes into red of a blue shade. We can picture what would have been Faraday's and Schönbein's ecstasy of delight at seeing their prophecy verified in such chameleon-like behaviour.

I have referred to Viscose silk. What would Faraday have said, if told that we had not only found "tongues in trees" and gone far to discover "good in everything" but also that, spider-like, we had made the mere timber of trees into a veritable silken web, carrying colours of every hue made from his benzene, a material found worthy of notice even by a Chancellor of the Exchequer and actually worn not by Queens alone but also by most of their female subjects? Could we tell him these things, might he not well ask what is left for poor Nature to do: at the same time, he would be the first to recognise that we had studied "natural things" to some purpose and had he foreseen the power chemists were to wield over Nature, he would perhaps have elected to remain a chemist and have thought little of electricity—as do chemists to-day.

We may go further still in tracing the scientific progress of benzene. It is written that "the last shall be first." Benzene, however, retains its dominance and is everlasting. The discovery of the first Fullerenian professor, benzene and its descendants are now the objects of most serious attention by the latest holder of the chair. Racked upon his goniometer, tortured by X-rays, they are being forced to disclose the secrets of their inmost atomic centres: their molecular dimensions are being determined in ultramicroscopic terms. Faraday would not have been surprised: he would have been the first to welcome such achievements but with reverence, as well as delight at our progress.

By some uncanny mental process, the chemist has prophesied what X-rays are justifying; and now a new era is upon us, one for which we must prepare ourselves. Like Faraday, we must have many-compartmented minds. We must learn to think in the solid. The

chemistry of the future will be spatial in dimensions and distribution. It will be in no slight degree a science of solid geometry. I have here a model of benzene in terms of units such as X-rays reveal to us in the diamond. Mr. William Barlow and I desire to lay this to-day upon Faraday's table as a solid tribute to his memory: it is something more than a mere symbol: we believe it to be a very close approach to the geometrical structure of the molecule. It is something I have hoped for during the whole of my life. There are other models here, made by Mr. Barlow, of various derivatives of benzene, all in close accordance with crystallographic data.

To return to colour, the colour-chemist to-day is a super-magician. If women could be scientific, they would insist upon being stamped all over, not with a king's cartouche, such as we have seen was used on Tut-ankh-Amen's tomb; no, with the hexagon symbol of benzene, as the emblem of the colours in which they are now arrayed far more gloriously than were ever the lilies which Solomon, we are told, could not rival. To-day, we can paint the lily with its own colour. We make the colours of the lily, indeed those of most flowers, in the laboratory, actually from benzene. Faraday, in Sandemanian moments, would almost have regarded this as sacrilege.

To-day is no common occasion and we desire to deal with it in no common way. This commemoration is held at the instance of a remarkable and unusual conjunction: by the Royal Institution, acting together with the Chemical Society, the Society of Chemical Industry and the Association of British Chemical Manufacturers—a trinity completely representative of English chemical interests. Chemists desire to show that for once they can think together. We together acclaim the memory of Faraday—of Faraday the complete philosophic chemist. Moreover, our committee has decided to take in hand the preparation of a medal, to be awarded at intervals, perhaps sexennially, without regard to nationality, for an outstanding achievement in some clear relation with Faraday's discovery of benzene. We desire not only to keep his influence alive but also to extend it. We propose to follow a well-known practice of the clergy and make the first award, in anticipation, to-day. We ask Mr. James Morton, of Carlisle and Grangemouth, to accept promise of the first Faraday Benzene Centenary Medal, in special recognition of the signal service he has rendered to chemical science and industry in Great Britain, during the past ten years, by developing and extending the manufacture of the anthracene vat-dye-stuffs and, more recently, by extending their application to silk and wool.

Faraday and his Contemporaries.<sup>1</sup>

By Prof. ERNST COHEN.

YOU all know Lord Byron's reply to the malignant diatribe on his "Hours of Idleness," published by the *Edinburgh Review*, the slating critique which advised him "that he do forthwith abandon poetry, and turn his talents, which are considerable, and his opportunities, which are great, to better account."

Some years afterwards Byron himself admitted that he had gone too far in his "English Bards and Scotch Reviewers," saying: "The greater part of this satire I most sincerely wish had never been written, not only on account of the injustice of much of the critical and some of the personal part of it, but the tone and temper are such as I cannot approve." Not only did he attack in this most vehement effusion the achievements of English literature, but also he fretted and fumed about those produced by contemporary science:

"Thus saith the Preacher: 'Nought beneath the sun  
Is new; yet still from change to change we run;  
What varied wonders tempt us as they pass!  
The cow-pox, tractors, galvanism, and gas,  
In turns appear, to make the vulgar stare,  
Till the swollen bubble bursts—and all is air!'"

The word "tractor" wants explanation, as its meaning differs from that which it has to-day.

About the year 1796 an American physician, Dr. Elisha Perkins, invented an instrument, which he named "metallic tractors," for the cure of local pains, inflammations, and rheumatism. The tractors, he claimed, were of peculiar and secret composition, but it is asserted that one was of iron, the other brass. They were three inches long and pointed. In use they were drawn downward over the affected part of the patient for twenty minutes. Dr. Perkins' son published a book in London, introducing the method, and it inspired so much faith that a Perkinsian Institution was opened, of which Lord Rivers was president. Recommendations were signed by many physicians and clergymen and thousands of cures published, so that

the inventor pocketed a considerable sum of money. Heated discussions arose, and James Gillray, the celebrated caricaturist, lampooned the matter in his production "Metallic Tractors," where Dr. Perkins is seen trying to restore, by means of his instrument, the normal shape of the nose of a drunkard.

That Byron had been absolutely wrong so far as gas bubbles are concerned is evident from the most interesting addresses we had the good fortune to hear a few moments ago, as gas was the material to which we owe Faraday's wonderful discovery of the foundation-stone of a major section of organic chemistry and of the synthetic dye-stuff industry.

If Byron had been right where he mentions Dr. Jenner's magnificent invention, what would have been to-day the aspect of this assembly?

Allow me to remind you in this place where chemists from all parts of the world are gathered to-day to do homage to the memory of one of the most admirable geniuses, of one of the most noble characters England ever produced, that Byron continued his comedy of errors when he ridiculed the achievements with which Galvani and Volta as well as Humphry Davy had presented natural philosophy. This can scarcely be done in a more striking way than by resuming, be it only in a few words, what the human race owes to Michael Faraday in his capacity of a physical chemist, especially in that branch of our science which was so mercilessly attacked by the author of "English Bards and Scotch Reviewers."

Two years after the discovery of benzene, Faraday published his "Chemical Manipulation." This title is far too narrow, as we have to deal with an almost complete laboratory companion for physico-chemical work. In none of our contemporary books on this subject is so much stress laid upon the necessity of cleanliness in laboratory work, none of them gives so strong evidence as Faraday's manual that Peter Riess was absolutely wrong in his definition of chemistry:

<sup>1</sup> Address delivered at the Royal Institution on June 16, the Duke of Northumberland in the chair, at the celebration of the centenary of the discovery of benzene by Faraday.

"Die Chemie ist der unreinliche Teil der Physik," which runs in plain English: "Chemistry is the dirty part of physics." Every page of this most valuable book not only shows the author's passion for his subject, but at the same time his extraordinary skill as an experimenter, who tries to perform the operations, when desirable, with the smallest number of requisites. Years afterwards this faculty of Faraday's was symbolised by a most charming cartoon of *Punch* with this legend: "Faraday giving his card to Father Thames; and we hope the Dirty Fellow will consult the learned Professor." The adjoined text runs as follows:

"A PHILOSOPHER AFLOAT.

"A chemical work of small size and great importance has been lately published. The production alluded to is Faraday on the Thames, a title which means even more than it appears to mean; for it not only expresses Professor Faraday's views of the composition of the river, but also describes the sensations experienced by him during a period of brief transit upon its surface. A piece of white card, according to the professor, becomes invisible at a very small degree of submersion in the Thames water, which is of a peculiar colour—'opaque pale brown'-drab-quakerish—and a not very peculiar smell, because it partakes of that of the sink-holes, and may be described as odoriferous, but not fragrant. We have often had great pleasure in hearing Faraday explain the composition of water, pure and simple; but we rejoice much more that he has enabled the public to form a correct idea of the constituents of that of the Thames, which consists of something more than Oxygen and Hydrogen. Because we are losing brave men by war, it is rather the more desirable than otherwise that we should not also lose useful citizens by pestilence, as we certainly shall if the Thames continues much longer to be an open sewer. We hope that Professor Faraday's publication, which takes the shape of a concise letter to the *Times*, will effect a saving of human life still greater than that which has resulted from his predecessor's safety-lamp. Davy's invention prevents carburetted hydrogen from blowing up miners; may Faraday's epistle avert cholera and typhus by stirring up senatorial and municipal persons to prevent sulphuretted hydrogen from being disengaged."

In the year 1830 an event occurred in Great Britain which is to be considered as unique in the history of science. Let me tell you this historical story, as I did some time ago on another occasion.

Charles Babbage, then a professor in the University of Cambridge, published a small pamphlet, "Reflections on the Decline of Science in England and on some of its Causes," in which he tried to prove that England was, with respect to the more difficult and abstract sciences, not only below other nations of equal rank, but even below several of inferior power. It should be mentioned that this opinion did not remain unnoticed abroad. A short time afterwards a reply was

published to Babbage's book. Its title was, "On the Alleged Decline of Science in England," by a *Foreigner*. Now I found that this foreigner was Dr. Moll, then a professor of physics in the University of Utrecht. It may interest you also that I found that Faraday, who was an intimate friend of Moll's, paid the publishing expenses, Moll being unable to find a publisher. The Utrecht professor proved that Babbage was wrong. Here you see on the screen a caricature of the time, with the legend: "Dedicated (but not), with permission, to the British Association for the Advancement of Science." I have been able to prove that the men pictured represent Moll and Dalton meeting at the Royal Institution of Edinburgh, Dalton expressing thanks to Moll for having defended British Science. The name of the author of this picture, who hides behind the initials XYZ, is unknown up to the present.

Even to-day it can scarcely be understood how Babbage could express such an unfavourable opinion at a period when such a brilliant array of British names had become immortal by scientific labours. As if Faraday had cherished the desire to give the lie to Babbage's arguments, a few years later he presented science with the discovery of those wonderful laws which for all times will form the base of the theory of electro-chemistry. Do not suppose that this achievement was immediately unanimously applauded. I find in a letter of Berzelius to his friend Wöhler, written some months after the publication of Faraday's celebrated paper: "I have got Faraday's sixth and seventh paper and read his discovery of definite proportions of electricity, which has been so greatly extolled in England. It covers 4 sheets of printing, and is devilishly hard to read. Besides this the conceptions developed in this purely theoretical paper are so narrow that it declines very strongly my former opinion of Faraday." But some months later Berzelius again changed his mind, and in his review of Faraday's investigations, published in his *Jahresbericht* of the year 1835, he wrote these sentences: "As a matter of fact, Faraday created by his meritorious investigations the possibility of founding our theoretical conceptions on a more reliable base."

To-day we know that there scarcely exists any natural law which holds good within such wide intervals of concentration, temperature, and pressure as those discovered by this hero of science. From the chemical point of view it is to be emphasised that his investigations, which culminated in the demonstration that equivalent quantities of substances have equal quantities of electricity associated with them, disproved, once and for all, the Berzelian hypothesis that a greater quantity of electricity is needed to separate

a compound of a very positive with a very negative element, or radical, than is required to separate a compound of a less positive with a less negative element, or radical. But, at the same time, Faraday's researches strengthened that part of the Berzelian doctrine which asserted the existence of a close connexion between electrical and chemical forces.

Looking to-day at Faraday's words: "The electricity of the voltaic pile . . . is entirely due to chemical action, and is proportionate in its intensity to the intensities of the affinities concerned in its production, and in its quantity to the quantity of matter which has been chemically active during its evolution," we immediately recognise in them the roots of the magnificent development which the doctrine of chemical affinity has shown since those times by the labours of

Willard Gibbs, von Helmholtz, and van 't Hoff. While the whole of the present electric industry is based on Faraday's discoveries in the fields of converting electric energy into mechanical power or, reciprocally, of obtaining electric energy by an expenditure of mechanical work, electro-chemical industry owes its existence to his far-reaching researches in the field of chemistry.

It would be carrying coals to Newcastle to give here an account of the influence of these achievements upon our purely theoretical conceptions and upon the conveniences of modern life, which could never have been dreamed of by our ancestors. Recalling this to mind, we cannot but repeat Shakespeare's words:

"He was a man, take him for all in all,  
I shall not look upon his like again."

## The Royal Institution.

### NEW HONORARY MEMBERS.

THE proceedings at the centenary celebrations at the Royal Institution were marked by the presentation of diplomas of honorary membership to six distinguished foreign chemical workers. The presentations were made by the president of the Institution, His Grace the Duke of Northumberland, and the recipients, two of whom were represented by fellow-countrymen who were able to be present, were introduced by the secretary of the Institution, Sir Arthur Keith, in the following words:

GABRIEL ÉMILE BERTRAND, professor of biological chemistry at the Sorbonne, Paris, and Director of the Laboratory of Biological Chemistry at the Institut Pasteur. Prof. Bertrand is distinguished as an inquirer into bacterial activity, particularly in connexion with oxidation phenomena, of which he has made a special study. He has also paid great attention to the influence of minute quantities of metals not usually regarded as acting upon the course of vital change.

ERNST JULIUS COHEN, professor of general chemistry and inorganic chemistry, University of Utrecht, Holland. Prof. Cohen is an acknowledged leader in physical chemistry, the biographer in England of his master, Van 't Hoff, and like him, a devoted student of Byron.

PIERO GINORI-CONTI, Senatore, president Associazione Italiana de Chimica, Generale ed Applicata, Rome, Italy. Prince Ginori-Conti has acquired distinction by capturing natural steam and using it as a source of energy, at the same time extracting from it large quantities of boric acid. He manufactures per-

borates from this latter by Faraday's method of electrolytic oxidation.

JAMES FLACK NORRIS, professor of organic chemistry, Massachusetts Institute of Technology, and secretary of the American National Research Council. Prof. Norris is president of the American Chemical Society, a constituency of 15,000 chemists. He is professor in the most noted of American Technical Schools, the Massachusetts Institute of Technology, and himself a well-known original worker.

JOJI SAKURAI, president of the Japanese National Research Council, emeritus professor, Imperial University of Tokyo, Japan, and member of the Japanese House of Peers. Prof. Sakurai was a student under the late Prof. A. Williamson at University College, London, one of the first small band of Japanese students who came to Europe to acquire a knowledge of western science. Working upon foundations laid by the late Prof. Divers, he has long been noted as the inspiring mind in Japanese chemistry. A founder of the National Research Council of Japan, he is now actively engaged in promoting the application of science generally in his country.

FREDERIC SWARTS, professor of chemistry, University of Ghent, Belgium, and member of the Royal Academy of Belgium. Prof. Swarts is the son and successor of the successor of Kekulé in Gand. His father was Kekulé's assistant at the time (1868) Sir James Dewar worked in Gand, together with Körner, celebrated as the first to disclose the value of Kekulé's benzene symbol. Prof. Swarts is distinguished as a student of the organic compounds of fluorine.



